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BOMBAY, 1926.**

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INTRODUCTION.

EVERY large city in the world has had a humble origin, and risen to greatness by the gradual development of its trade and industries. The beginning of Rome, for example, was a small settlement on the Palatine Hill on the Tiber; the beautiful city of Paris has risen from an insignificant little island in the river Seine, and even the origin of mighty London "is now lost in oblivion."

Bombay is no exception to this. Originally an obscure little island inhabited by primitive fisherfolk, it was but a "poor little island," as Pepys described it, when ceded by the Portuguese. Its subsequent rise and growth has been full of vicissitudes, but in spite of numerous misfortunes, such as invasions of enemies, attacks by pirates, internal dissensions and intrigues, "pestilential fevers," famines, fires, financial crises and plague, Bombay through steady development of its industries and export trade, has now risen to the present position as the "Second City in the Empire."

Visitors will find Bombay interesting in many ways. Historically it dates from the times of Arrian and Ptolemy; geographically it consisted of seven little separate islands less than two hundred years ago; while ethnologically its cosmopolitan communities afford a deeply interesting study. The hills, suburbs and foreshores provide many pleasant excursions to botanists and zoologists, while archæologists find the city and its neighbourhood to be places of entrancing attraction. Its industries afford a great field of activities to capitalists; town planners find it an ideal place for the exhibition of their energies, while some of its public health problems have baffled the greatest sanitarians and engineers. Lastly to artists it reveals innumerable beauties of landscape, figure, seascape and architecture.

Such is Bombay. This handbook is a small attempt to give the visitors to the Sixth Session of the Indian Science Congress a brief description of the city, its history, climatology, geology and botany together with a short account of the various objects and places of interest in and around it. To those who have so liberally responded to appeals for contributions, the writer begs to express his deep indebtedness and cordial thanks.

D. A. TURKHUJ.

BOMBAY, *January* 1919.

—“ 1926 ”—

The Hand-book of 1919 was an admirable production and it was, therefore, naturally desirable to retain the character of the book in its main form. But that was presentation of the Bombay of 1919. Things have changed considerably since and many of the important changes, that occurred in Bombay in the past six years in regard to its industry, education, art and civic life, have to be recorded. I was fortunate to secure fresh articles—they are marked with an asterisk—on various subjects written by authorities and to that extent the task of editing the book was very pleasant.

I beg to express my gratitude to all those who were kind enough to assist me in every respect. I wish the book turns out to be a fitting souvenir.

G. R. PARANJPE.

BOMBAY, *January* 1926.

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Bombay Past and Present.

THE ORIGIN OF THE NAME OF BOMBAY.

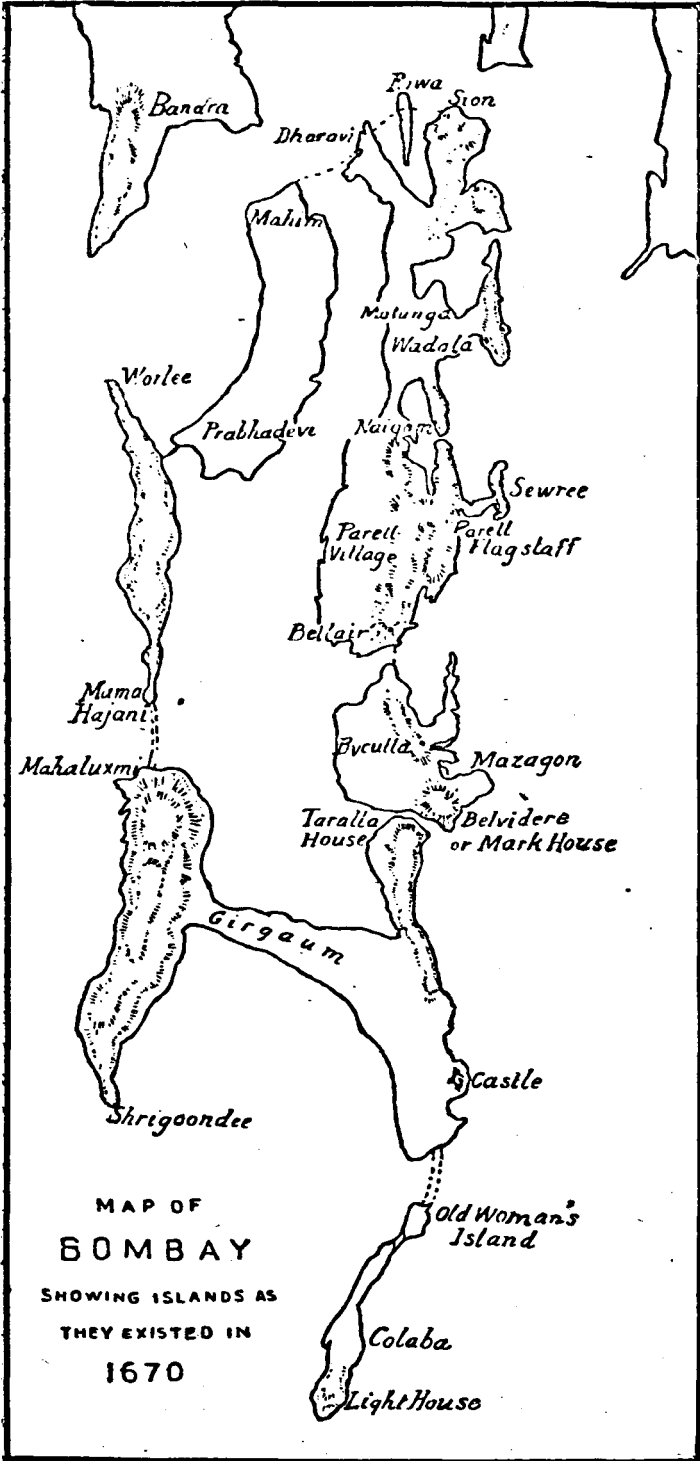
THE name Bombay is derived from "Bombaim," a Portuguese corruption of the original name of the place, viz., *Mumbai*. In the time of the early Portuguese we find it referred to as Mombaim as well as Bombaim; the celebrated physician and botanist Garcia da Orta (1490-1570) who himself lived in Bombay for sometime and to whom the King of Portugal had made a grant of this island, uses both the names. The name Mumbai is derived from "Mumbā Āi," mother Mumbā a name of Mumba Devi, the patron goddess of the Kolis or fishermen, the original inhabitants of these islands. "Mumbā" is probably a shortened name for "Mahā Ambā," the great Ambā, wife of Siva. The temple of the goddess originally stood close to the spot now occupied by the Victoria Terminus station; the original temple was probably destroyed when Mubārak overran these islands about the year 1320. The temple was evidently rebuilt subsequently, and stood there until 1760 when in order to complete the Esplanade and erect new fortifications it was removed and re-erected on its present site in the heart of the town.

HISTORY.

IN the prehistoric period Bombay appears to have formed a part of the mainland of India but eventually to have become gradually separated from it by volcanic action into a number of small islands. Geologists say that man probably made his first appearance on them during the Stone Age, for, tools of flint, similar to those once used by the cavemen of Europe have been found along the shore of the mainland as well as that of the Back Bay. Forests of Khair trees (*Acacia catechu*) covered the land and the prehistoric man then lived by hunting in the jungle and fishing in the sea. During the work of excavating the foundation of the Prince's Dock a petrified khair forest was discovered 32 feet below the high water mark; the trees were embedded in a decayed trap-rock soil overlaid by the thick stratum of clay which formed the real bottom of the harbour. These fishermen and hunters of the Stone Age were probably the forefathers of the Kolis, the original inhabitants of these islands. The palm trees appeared later on, and with them came the Bhandāries or palm-tappers. These pre-Aryan tribes

were in all probability the settlers on the islands of Bombay about 800 years before Christ, when the Aryans came into the Deccan. But old records have shown that as early as 1000 B. C. the Aryans had already settled on the Indus and that Western India was carrying on trade with Persia, Babylon and Egypt by way of the Persian Gulf and the Red Sea. Salsette was the chief centre of commerce for this Mesopotamian trade until the fourth century before Christ. The neighbouring seven little islands of Bombay (see Map I) however were still unknown and unimportant, but they formed an outlying portion of the kingdom of the Northern Konkan, or Aparānta of the old Sanskrit writings. One of the earliest rulers of the territory was the great Buddhist King Ashoka, but the only evidence of this rests on an Ashoka inscription found at the town of Sopara—the ancient Ophir—in Salsette. After the death of Ashoka, Aparānta passed into the hands of Sātavāhana kings from the south who increased the trade with the west to such an extent that hordes of Greeks (Yavanas), Scythians (Sakas), and Parthians (Pahlavas) invaded the Deccan and Konkan; but they became merged among the Hindoos and Buddhists and eventually ousted the Sātavāhanas. During the time of these foreign Kshatrapas, Broach (Barygaza) and Kalyan (Kalliena) became the chief trading marts; and the group of the seven islets of Bombay was probably the Heptansia referred to by Ptolemy in the second century A. D. During the time of the Maurya and Chālukya dynasties which succeeded (Circa 450-750 A. D.) the capital of their territory was Puri—Mangalpuri—founded by the Chālukya King Mangalraj, on the island of Elephanta in the Bombay harbour. But it was during the rule of the succeeding Silhāra chiefs (810-1260 A. D.), when the temple of Walkeshwar was built at Malabar Point, that Bombay began to attract visitors from Malabar—hence the name Malabar Hill—and other parts of Western India, on account of the fame of the temple, and the extraordinary sanctity attached to “Shrigundi” or the Holy Rock in the sea close by. This temple was apparently destroyed during one of the raids on Bombay either by Mubarak or the Portuguese. In 1672 Dr. Fryer spoke of it as the “remains of a stupendous Pagoda” and according to Moore “the remains of a rather elegant temple” still existed at Malabar Point early in the 19th century. A temple built about the same period (1060 A.D.) still exists in a fair state of preservation at Ambarnath in Thana District.

About the year 1260 Raja Bimbdev driven out of his kingdom in the Deccan by the Muhammadans under Allauddin Khilji, came over to these islands and founded a city called Mahikāwati, the present Mahim. There he built a palace for himself and a temple to his family Goddess Prabhāvati—probably where the temple of Prabhādevi now stands—and a Court of Justice ;



his numerous retainers and followers who were chiefly Prabhus, Palshikar Brāhmins and Pānchkalshis came with him and settled in the neighbourhood of Mahim. In 1348, however, the islands of Salsette and Mahim were attacked by a Muhammadan army from Gujarat. Nāgardev, the ruler of Mahim, happened to be away at Walkeshwar when the place was invaded. His Rani, however, offered a most heroic defence, but was defeated and killed; the city was looted and Nāgardev while coming to her assistance was also attacked and killed in a fight near Byculla, and Bombay passed into the hands of the Sultan of Gujarat. The Muhammadan rule lasted from 1348 to 1534. The sultans established a military outpost at Mahim, and it was during this period that the well-known shrine was built at Mahim for Makhtum Fakih Ali Paru, an Arab Pir or saint who died there in 1431. The Muhammadan rule, however, was only nominal, for the real administrative powers were in the hands of tributary Hindu Chieftains.

The Portuguese came to India towards the end of the fifteenth century, soon became masters of the Indian Ocean, and in 1510 took Goa. In 1534 they seized Bassein and forced Bahadurshah, Sultan of Gujarat, to bequeath to the King of Portugal and his heirs for ever the city of Bassein, its territories, islands and seas. The Bombay islands thus passed from Muhammadans to Christians. The Portuguese divided the islands into Manors or fiefs which were granted as rewards to deserving individuals who in turn were bound to furnish military assistance to the King of Portugal in times of necessity, while to the various religious orders the land was given free for ever.

One of the first lessees of "Mombaim" or "Bombaim," as Bombay was then called, was the celebrated Portuguese physician and botanist Garcia da Orta, the author of "Colloquies on the Drugs of India." He paid an annual quit-rent of £85 for it and lived in the "Quinta" or Manor House built sometime in the sixteenth century and which stood upon the site of the present Arsenal behind the Town Hall. It contained a fine library of historical, philosophical and medical works, and was surrounded by "a delicate garden voiced to be the pleasantest in India." It was partially burnt by the Dutch and English in 1526, but still remained standing in a more or less dilapidated condition in 1665, when Donna Ignez de Miranda, the proprietress of the Manor of Bombay handed it over to the British representative Humphrey Cooke. In the case of the various Roman Catholic religious orders, the land, chiefly in the northern parts of the island was, as stated before, freely given them for ever. Thus Franciscans and Jesuits were able to build several churches, notably those of N. S. de Esperança on the Esplanade, now destroyed, San Miguel at Mahim, N. S. da Salvacao at Dadar, and one at Parel, which is now the Bombay

Bacteriological Laboratory, but the name of whose patron saint is not known.

In the meantime the English merchants who had settled in Surat were already coveting Bombay. As early as 1652 their Council had urged the Directors of the East India Company to purchase it, and the Directors in their turn had pressed upon Oliver Cromwell the strategic importance of the island and the excellence of its harbour.

The 23rd of June 1661 stands out as an all-important date in the annals of Bombay. For, on that date was signed at the Palace of Whitehall in London the Marriage Treaty between Charles II of Great Britain and Catherine Braganza of Portugal, whereby the Princess brought with her as part of her dowry "the Port and Islands of Bombay and all the rights, profits, territories, and appurtenances thereunto belonging," and which were to be handed over to "the King of Great Britain, his heirs and successors for ever." There was also a secret article in the Treaty by which the King of England guaranteed the Portuguese possessions in India and undertook to act as mediator between the Portuguese and the Dutch. The cession of Bombay was bitterly opposed by the Portuguese in India, and it was not until 1665 that Humphrey Cooke acquired actual possession of the island and in token thereof "took in his hand earth and stones and walked upon the bastions of the Bombay Castle." The various religious orders, however, still retained their hold upon the northern portion of the island declaring that it was their private property, and it was only through the vigorous action of Humphrey Cooke and his successors that Mahim, Sion and Parel were forcibly taken and incorporated with Bombay proper.

The authorities in England, however, seemed to possess very vague ideas about the size and situation of the "poor little island." Even the Prime Minister, Earl of Clarendon, imagined that "the Island of Bombay with the town and castle thereon" was a vast territory which was "within a very little distance of Brazil!" At the time of the cession the revenues of Bombay were very small and derived from cocoanut and date palms growing between the Esplanade and Malabar Hill and at Mahim, and also from paddy fields on the low-lying grounds. The rest of the island was swampy, barren and uncultivated. The population which was estimated at 10,000 was chiefly composed of "outcastes" and "fugitives and vagabonds"; but it must be said that there was among them a small industrial element composed of fisher-folks and husbandmen with a sprinkling of Prabhus, Brahmans and Muhammadans.

In 1668 Bombay was transferred under a Royal Charter from the Crown to the East India Company, and thenceforward it was to be held "in free and common socage as if the Manor

of East Greenwich " at a farm rent of £10 payable annually; also it was to be made into a port, and immigration was to be encouraged. Sir George Oxenden was the first Governor of Bombay under the Company's rule, but he never resided there for any length of time. It was under his successor Gerald Aungier that "Bombay became the established seat of the Company's rule, and the rest of the factories in Western India, including Surat, were placed in subjection to it." This great and wise Governor may be said to be the real founder of the modern Bombay about which he then spoke as "the city which by God's assistance is intended to be built." He strengthened its defences, settled the land revenue, established law courts, founded a mint and coined the first rupee, built a small hospital, created punchayats, opened a printing press, and secured the freedom of trade and worship to all comers; in short, "he set himself to weld into one homogenous mass the discordant materials of Asiatic nationalities, so that a great multitude of men of diverse religions and races should live together in peace and harmony, free from discord within and aggression from without, and he did it." By means of these measures the population of Bombay increased to 50,000 and among the most important of the new settlers were Banias, Armenians and Parsis. Gerald Aungier has no monument in Bombay, except perhaps the remains of the old castle walls. He died at Surat in 1677 and lies buried there in a grave which has only been identified and named within the last few years. Byron's lines to Florence for her neglect of Dante may with equal force be applied to Bombay for her treatment of Aungier.

Unfortunately in the last quarter of the seventeenth century, partly through the silting up of the creeks that separated the component islands, and partly through defective sanitary conditions, Bombay, "one of the pleasantest spots in India seemed no more than a parish grave-yard." In 1689 it was "nought but a charnel-house in which two monsoons were the age of a man." The chief diseases were "fluxes, dropsy, scurvy, barbiers or the loss of the use of hands and feet, gout, stone, malignant and putrid fevers"; plague, and "mordexin" (cholera) were also very prevalent. In 1706, Governor Waite wrote, "we are only eight including the Council and but two that write and most of us sick on this unhealthful depopulated and ruined islands," and in response the Court of Directors despatched Surgeons on the munificent salary of 45 shillings per month with medicines which deteriorated on the voyage! In 1718 the population had dwindled to 16,000. The high mortality was attributed to three causes: (1) "pestilential deposits" on account of the silting up of the creeks, (2) manuring of toddy palms with putrid fish, and (3) indissolute living. In spite of all these drawbacks, and the unwelcome visits of the Siddi

admirals and pirates, the work of the town defences was pushed on; in 1716 the town walls were completed and the place made more secure, and as a consequence, settlers again began to come in.

In 1736 the dockyard was extended under the supervision of Lowji Nusserwanji Wadia, a Parsi Shipbuilder from Surat, and the defences of the town were further strengthened in 1744-48 and again in 1756-63. Sanitation was improved, a "Town Scavenger" was appointed, building laws were promulgated, and by 1744 the population increased to 70,000. In 1750 and 1756 more docks were opened and the number of trading vessels consequently increased. About the year 1770 the extension of the town was taken in hand, crowded and insanitary houses were demolished, the Esplanade was extended and levelled and every encouragement was given to the inhabitants to build their dwellings outside the Fort. In 1780 it was found that the population had increased to nearly 114,000. About this time the Company obtained Salsette and the adjoining islands in the harbour. The Vellard was constructed by Governor Hornby about 1784; it completely shut out the sea and prevented it from coming in and inundating the central portion of the island; the low-lying "flats" were thus rendered available for cultivation and settlement.

In 1800 the Governor Hornby's house in the Fort—the former Great Western Hotel—was made into a Court House where Sir James Mackintosh, a great scholar and judge, sat and decided civil and criminal cases. In 1803 a severe famine occurred in the Konkan and Deccan, and it brought a number of people to seek employment in Bombay. The same year a great fire destroyed a number of houses in the Fort, but it enabled Government to construct wider thoroughfares in the most congested parts of that locality; it also acted as a general incentive to the residents to build houses, shops and godowns outside the city walls. In 1814 the population had increased to 180,000.

In 1818 with the defeat of the Peshwa at Kirkee, the Company annexed the Deccan, and in the succeeding years, under the regimes of Mountstuart Elphinstone and Sir Bartle Frere, Bombay developed its trade with the mainland to a considerable extent. In 1830 Bore Ghaut road to Poona was opened, and in 1838 a regular monthly mail service to England was established. About this time considerable attention was paid to improving the sanitation of Bombay; the "flats" were reclaimed, Colaba island joined by a causeway to the Fort, an adequate water supply was provided and the city carefully drained. The present Mint was built in 1827 and the Town Hall completed in 1833.

In 1858 after the Mutiny, Bombay reverted to the Crown. The G. I. P. Railway which had run its first train in 1853 from Bombay to Thana, a distance of 20 miles, constructed the Bore

Ghaut line in 1863. By 1860 Bombay became a great cotton market of Western and Central India, and its cotton trade increased to an enormous extent between 1861 and 1865 on account of the outbreak of the Civil War in America ; and during that time Bombay benefited to the extent of about 81 millions sterling owing to the cotton trade being diverted to it from America. But when the American War ended, the price of cotton fell at once, a crash came, and there were numerous failures ; the commercial stability of the city however suffered no permanent damage. The modern Bombay may be said to be built up and established during these years ; for it was during this period that those great engineering and reclamation schemes were formulated which have given this city, the magnificent public buildings facing the Back Bay, Dockyards and Light-houses, the Elphinstone Circle, the Railway Workshops, and the European General Hospital. The Government freely aided private enterprise in the task of improving and beautifying the island ; room was made for many of these improvements by the demolition of the city walls. About this time also the gas-works were constructed and the city lighted with coal gas.

The progress of the city has since then gone on by leaps and bounds. In 1875 King Edward visited Bombay as Prince of Wales and laid the foundation stone of the Prince's Dock. Since then extensive schemes of reclamation and other progressive measures have been carried out. With the invasion of plague the City Improvement Trust was created for the purpose of demolishing the insanitary areas and opening out the congested districts. With Tata's Hydro-electric scheme, electric mains have been laid and electricity is now available all over the city for practical purposes, *viz.*, for lighting and the working of Tramways and Mills and Railways. The reclamation of a large portion of the harbour has enabled the construction of the new and extensive Alexandra Docks and the Ballard Estate.

In 1911 Their Majesties the King-Emperor George V and Queen-Empress Mary landed in Bombay at the Apollo Bunder, and in memento thereof a superb gateway—the Gateway of India—designed by Mr. Wittet of this city in pure Hindu architecture, is erected at the place of their landing.

DESCRIPTION.

OLD local documents and the statements of early European writers have conclusively proved that Bombay originally consisted of seven separate islands (see Map I.) These, partly by the silting action of the sea, and partly by the human agency, have now been made into one island (see Map) which is 11½ miles long, 3 to 4 miles broad ; it is flanked by two parallel ridges of low hills, of which the eastern is the longer and ends in the sea

at Colaba, while the other ridge runs along the west of the island and terminates in Malabar Point ; between the two lies the shallow expanse of the sea, known as the Back Bay. The harbour lies to the east of the island of Bombay, between it and the mainland of the Deccan.

On a strip of land between the Back Bay and the harbour is situated the Fort, the original nucleus around which the city has gradually developed ; it is now chiefly occupied by Government Offices, public buildings, business houses and shops. The termini of the G. I. P. and B. B. & C. I. Railways are also situated in this part of the city. To the north of the Fort is the " Bazaar " with houses rising from three, four and even to six storeys in height, " some with elaborately carved pillars and front work." To the west is Malabar Hill, a fashionable locality from which a magnificent view of Back Bay and the town can be obtained. At the extreme point of Malabar Hill is Government House, while at the other end of Back Bay is Colaba Point with the Prong's light-house beyond. To the north of Malabar Hill, and its continuation, Cumballa Hill, is an embankment known as the Hornby Vellard which joins Cumballa Hill to Worli. Before its construction the central part of the island, on account of its low-lying position, was liable to be submerged at high tide. Now, however, this district forms the most important industrial part of the city. To the east is the hill of Mazagon, upon which in early days stood a whitewashed house which used to serve as a guide for vessels entering the harbour. It was once the residence of Sterne's Eliza (Mrs. Draper) and was known as Belvidere House ; it was demolished about 1864.

The northern part of the island consists of the districts of Mahim, Parel and Sion and still contains some marshy land. Mahim, which in ancient times was a flourishing island under Raja Bimbdev, is now a thickly wooded palm grove ; it is connected with Bandra by a causeway which is a continuation of the Lady Jamsetjee Road. In the District of Parel is situated the Bombay Bacteriological Laboratory, which in olden times was the official residence of the Governors of Bombay. To the extreme north is the district of Sion (derived from the Marathi " Simā," a boundary or limit) which is connected with the island of Salsette by the Sion Causeway built by Governor Duncan in 1805. The old causeway has lately been considerably widened by reclamation, and replaced by a magnificent carriage road.

These different parts of the islands are connected by the G. I. P. and B. B. & C. I. Railways which provide an ample service of local trains. There is an extensive net work of Electric Street Car Service and in addition to that taxi-cabs and hack victorias can also be engaged ; their tariff is fixed.

The principal Buildings and Hotels are situated in the Fort. The enormous Taj Mahal Hotel is a conspicuous structure along

the Apollo Bunder; in the vicinity are the Apollo Hotel and Hotel Majestic, and a little further north the Esplanade and Great Western Hotels; the latter in olden times was the Court of Justice.

The *Apollo Bunder* originally constructed by General Bellasis, was until recently the landing place for overseas passengers; it was decided to erect thereon a large archway to be called "The Gateway of India" in commemoration of the landing of King George V and Queen Mary on the 2nd of December 1911. The Arch was completed and opened by the Viceroy in 1924. An extensive view of Bombay harbour, its islands and of the distant hills of the Western Ghats can be obtained from this spot. Along the Bunder Road and overlooking the harbour is the *Royal Bombay Yacht Club* with residential chambers on the opposite side; further on is the Sailors' Home constructed at the expense of a former Gaekwar of Baroda, which is now used almost entirely as naval barracks. The *Bombay Radio Club* has its premises on the top floor of this building where reception of messages and experimental work can be carried out on a large scale. In the open space in front is the *Wellington Fountain* which was erected in memory of the Duke of Wellington who once resided in this island. In the crescent-shaped area to the north is the *Prince of Wales' Museum of Western India*. A statue of King George V in naval uniform stands in the compound. To the west of the museum building are *Elphinstone College, Law College*, and commencing from the latter and curving westward is an extensive pile of buildings, the *Royal Institute of Science* with its magnificent public hall, the gift of Sir Cowasji Jehangir. It is in this building that the 13th session of the Indian Science Congress is to be held. In the open space to the west is the *Band Stand*. To the south is the Cooperage on which in old days was situated a shed for storing "King's provisions," hence the name. In the vicinity are the *Admiral's House, the Princess Mary, Japanese and Commercial Gymkhanas*. Further south is the *Cuffe Parade* reclamation, and beyond it lies *Colaba* with the Afghan Memorial Church, Military barracks, Station Hospital, and the Colaba Observatory, the chief meteorological and seismological station for Western India.

To the north of the Royal Institute of Science, and situated along Mayo Road there is a long row of magnificent public buildings. The first is the *Secretariat*, the office of the Secretaries to Government. This Venetian-Gothic building which was completed in 1874 contains the Council Hall on the first floor. To the north of the Secretariat is the *University Senate House* or Convocation Hall where University degrees are conferred. The building is in decorative French-Gothic style and has in the gable a large circular window embellished with the twelve signs of the Zodiac in stained glass. The next building

is the *University Library* and *Rajabai Clock Tower*. The Tower which is the gift of Mr. Premchand Roychand of this city is 250 ft. high, and forms a very conspicuous land-mark not only from Malabar Hill, but also from across the harbour, and even from steamers when out in the Arabian Sea. Both these buildings were designed by Sir Gilbert Scott, R. A. To the north and the south of the main University Buildings are the additional buildings which provide accommodation for the University Offices and Meeting Rooms, Examination Halls, Schools of Economics and Sociology and the Head Quarters of the University Training Corps. To the north of the University Buildings is the *High Court*, a huge pile in early English-Gothic style with the figures of Justice and Mercy near the central tower. Further north is the *Public Works Secretariat* and beyond it is the *Telegraph Office*. The large open space in front of all these buildings, known as the "Oval" on account of its shape, is often utilized for holding sports. To the north of the Oval and opposite Churchgate Street Station are the *Offices of the B. B. & C. I. Railway*, a Gothic structure with Indo-Saracenic domes ; the central gable of the west facade is surmounted by a group of figures by Roscoe Mullins representing "Engineering." Further along Mayo Road in the open space is a fine *statue of Queen Victoria* by Noble under beautiful canopy of Gothic design. In the vicinity are the offices of the *Improvement Trust*, *Bombay Gymkhana* and the residence of *Sir Dorab Tata*. Passing between the Public Works Secretariat and the Telegraph Offices is Churchgate Street and where it joins Esplanade Road, there is an open space with a fountain erected in honour of Sir Bartle Frere and known as the *Flora Fountain*. Near this spot, when the city had its fortifications around it, stood the western gate of the ramparts, *viz.*, the Churchgate. From this place Hornby Road runs to the north, and Esplanade road to the south ; the chief shops and Banking houses are situated in these roads. Churchgate Street ends towards the east in *Elphinstone Circle* in the neighbourhood of which there are some old buildings ; *St. Thomas' Cathedral* (1718), *The Mint* (1824), and the *Town Hall* (1833). The Elphinstone Circle houses were built about the year 1865. Behind the Town Hall is the Arsenal—a relic of Old Bombay—the old Portuguese Fort, which still retains the ancient fortifications. To the north of the Mint are the offices of the *Bombay Port Trust* and close by, the reclamation for the Alexandra Docks. At the entrance to the reclamation stands the New Custom House and at the end of the mole a railway station. Even large steamers can now touch the dock-wall and up-country passengers can entrain direct to their destination. This place is known as the Ballard Pier.

Hornby Road, a little to the north, joins Cruickshank Road, and here in the open space stands *Victoria Station*, the terminus of the Great Indian Peninsula Railway, and said to be one of

the most beautiful Railway Stations in the world. It stands on the original site of the old temple of Mumbadevi, the patron Goddess of the island. To the east is the newly built *Post Office*, a handsome pile of Indo-Saracenic architecture. Behind it lies *St. George's Hospital* for Europeans, and in the compound a portion of the old wall of Fort George which formerly stood there, can still be seen. Opposite the Post Office, near Bazaar Gate Police Station stood the old Bazaar Gate of the ancient ramparts. Facing Victoria Terminus are the *Municipal Offices*, the foundation stone of which was laid by Lord Ripon in 1884. *The Masonic Hall* in Ravelin Street, and *Excelsior Theatre* are also in this vicinity. To the west is an extensive open space known as the *Esplanade*. Here in former times stood one of the oldest Portuguese churches in Bombay, viz., that of Nossa Senhora da Esperanca, Our Lady of Hope, which had to be razed to the ground in 1760 as it came in the way of the guns of the fort ramparts. The place is now marked by a cross which stands near the barracks of the old Marine Battalion. In the vicinity is the *Marine Lines Hospital* for Indian Soldiers, and to the west facing the Queen's Road are quarters for Military Officers. Along the continuation of Hornby Road northward, beyond the *Times of India* Building, is the *Sir J. J. School of Art*; further on are the *Sydenham College of Commerce*, the *Police Head Quarters*, and to the east the *Crawford Market* named after Mr. Arthur-Crawford, who held the post of Municipal Commissioner from 1865 to 1871. Along Cruickshank Road commencing from the Municipal office will be seen the *Police Courts*, the *Allbless and Cama Hospitals* for women and children, *St. Xavier's College*, *Elphinstone High School*, and the *Secondary Teachers' Training College*. Esplanade Cross Road begins here and runs eastward and along it are *St. Xavier's School* with a tower 120 feet in height *Gokuldas Tejpal Hospital* and the *Police Offices*.

The City proper lies to the north of the Esplanade Cross Road. The continuations of Esplanade and Hornby Roads, viz., Kalbadevi Road and Abdul Rehman Street respectively, meet ultimately at Pydhowni or the "foot-washing place" where in olden times the sea used to come in and in which the passers-by used to wash the dust from their feet. In this part of the city are situated the *Roman Catholic Cathedral* (Our Lady of Hope), erected in place of the old church on the Esplanade, the *Mumbadevi Temple* of the Hindus which replaces the original temple of the patron goddess of the island, and the *Juma Masjid* of the Muhammadans. Moreover the cloth and silver markets are also situated in this locality. Further north is the old Jail built in 1804, and a little beyond are the extensive grounds occupied by the *Janusetjee Jeejeebhoy Hospital*, the *Cowasji Jehangir Ophthalmic Hospital*, *Bai Motlabai Obstetric Hospital*, the *Petit Hospital* for women and children, and a large residential hostel

for medical students. These are the chief Hospitals for clinical medical instruction in Western India, and attached to them is the teaching institution, the *Grant Medical College*, named after Governor Grant and opened in 1845. The *F. D. Petit Laboratory* for research work and the newly built *Physiological and Public Health Laboratories* are also situated in the same compound. The *Northcote Police Hospital* is close by and further west is *Byculla Club*.

The wide carriage drive which skirts Back Bay is known as Queen's Road (See Map). Commencing at the B. B. & C. I. Railway Offices, it passes the *Bombay Brigade Office*, and Military Officers' quarters, the railway line running parallel to it on the west. Further on the road passes by the *Hindu Burning Ground*, the *Muhammadan Burial Place*, and a disused *Christian Cemetery*. In olden times the sea used to come quite close to these cemeteries which were situated on the sandy beach of Back Bay. Queen's Road then passes by the *Royal Opera House* over the Sandhurst Bridge where it divides into Chowpaty and Hughes Roads. The former runs along Back Bay, and as Walkeshwar Road passes up Malabar Hill, by the lower entrance gate of Government House compound, and a little further up joins Ridge Road. Walkeshwar Road then passes Walkeshwar temple, which lies to the right, and ultimately ends at the upper gate of the Government House Grounds. *Government House* itself is situated at the extreme point of Malabar Hill and consists of a number of small marine villas. Ridge Road runs northward practically along the top of the Hill between fashionable residences to the *Malabar Hill Reservoir*, and a pretty garden from which magnificent view of Back Bay, the southern part of the city, the harbour and its islands and even the mainland of the northern Konkan beyond, can be obtained. The road then passes further north as Gibbs Road with the *Parsi Towers of Silence* to the left and the *Hindu Temple of Babulnath* to the right, until it joins Hughes Road. A turn should here be taken to the left which brings one to Warden Road which passes by the *Mahaluxmi Battery*, the *Parsi General Hospital*, the *Swimming Bath*, and the *Mahaluxmi Temple* until it reaches *Hornby Vellard*. The Vellard which was built by Governor Hornby effectually checked the inroad of the sea at the place and by reclamation rendered available for cultivation and settlement a wide area of low-lying land to the east, and "welded the eastern and western shores of the island into one united area." At the southern end of the Vellard, out in the sea, can be seen the *Durga of Haji Ali*—a Muhammadan Pir; it can be visited only during low tide. At the further end of the Vellard is the palace of H. H. Maharaja Scindia and close to it is the tomb of *Mama Hajani*, another Muhammadan Pir, sister of Haji Ali. The road then passes on to Worli by the *Love Grove Pumping Station* where the major portion of the sewage of

Bombay is pumped out into the sea by means of very powerful machinery. To the east of the Vellard are the *Willingdon Sports Club* with its extensive grounds, and the *Race Course*. To the north and east lies the industrial centre of Bombay with its innumerable chimneys. To the east is *Jacob's Circle* where seven roads meet from different parts of Bombay. A handsome drinking fountain in memory of General Legrand Jacob ornaments the centre of the circle. Further east was the *Victoria Jubilee Technical Institute* which has now gone into its own buildings at Matunga; and opposite to it, the *Victoria Gardens* which contain the Victoria and Albert Museum, a well laid-out botanical garden, and a collection of wild animals and birds. In the vicinity is the *Maratha Hospital* for plague, and near Jacob's Circle, the *Arthur Road Hospital* for Infectious Diseases.

Further north in Parel District is the *Bombay Bacteriological Laboratory*, now known as the Haffkine Institute, a large building which in former times was the residence of the Governors of Bombay. Close to it are the *King Edward VII Memorial Hospital* and the newly opened *Seth Gordhandas Sunderdas Medical College* with all its museums, laboratories and a students' hostel.

To the east beyond Golanji Hill is *Sewri Cemetery* which in olden days was the site of the Agri-horticultural Society's Garden. Further north is the *Acworth Leper Asylum*, with a beautiful garden, a sewage installation and a sewage farm which are well worth a visit. Vincent Road passes through the middle of this part of the island and is the main road which leads from Bombay to the mainland.

To the north of the Vellard is Worli, now a fishing village, but which had a fort of its own. The largest number of cement chawls, built by the Bombay Development Department for providing housing accommodation to Mill-hands, are found in this region. To the north-east is Mahim which in ancient times was a flourishing island named Mahikāwafi under Raja Bimb; there is no trace left now of its ancient greatness, but its old temple Prabhadevi (but not the original one) is still in existence. This district shows a thick cultivation of cocoanut palms, known as *Mahim Woods*. In the northern part of Mahim there is an old shrine in which a Muhammadan Pir named *Makhtum Shah* was buried in the fourteenth century. Mahim has also two old Portuguese churches, viz., that of Nossa Senhora da Salvacao, Our Lady of Salvation, and that of San Miguel; the latter stands at the end of Lady Jamsetji Road, while on the opposite side of the road is the *Mahim Fort*. Mahim is connected with Bandra by the *Lady Jamsetji Causeway*, and with Sion by a very tortuous old narrow road which passes through a marshy locality.

The Tannery of the Western India Boot and Equipment Factory is located in this district. At Sion there used to be an old fort where the Commandant of the Militia used to reside. Sion is now joined to the mainland by a magnificent carriage road which lies to the west of the G. I. P. Railway line. It has recently been made by reclamation, and it replaces the old *Duncan's Causeway*.* A very large road has now been constructed through the city and from Byculla it passes through Lal-Bagh, Parel, Dadar. Further on it is known as the King's Way and goes upto the *King's Circle* at Matunga. Half-way on this road, to the right, going northward, are the new premises of the *Victoria Jubilee Technical Institute* and the *Laboratories of the Indian Central Cotton Committee*.

*On modern principles of town planning, new and elegant suburbs are developed at Dadar, Matunga, Khar, Chembur, Santa Cruz and various other parts in the northern districts of Bombay. The localities are generally very clean and healthy, are provided with broad asphalt roads and are lighted by electricity. Most of the houses in these areas are either private houses or built by various Co-operative Housing Societies. It is very interesting to note that almost all the improvement has been achieved during the last decade or so.

POPULATION.

The following figures are interesting and show the progressive increase of the population of Bombay, and how the little island of "outcastes" and "fugitives and vagabonds" has within 220 years risen to be "the Second City in the Empire":—

Year.					Population.
1668	..	..	..	..	10,000
1744	..	..	..	..	70,000
1780	..	..	..	..	113,726
1814	..	..	..	..	180,000
1836	..	..	..	..	236,000
1846	..	..	..	..	566,119
1864	..	..	..	..	816,562
1872	..	..	..	..	644,405
1881	..	..	..	..	773,196
1891	..	..	..	..	821,764
1901	..	..	..	..	776,006
1906	..	..	..	..	977,822
1911	..	..	..	..	979,445
1921	..	..	..	..	1,175,914

According to Religions the population of 1921 was as follows :

Hindus	..	..	..	837,690
Mussalmans	..	..	..	184,685
Christians	..	..	..	68,169
Zoroastrians	..	..	..	52,234
Jains	..	..	..	23,884
Jews	..	..	..	7,548
Other religions	..	..	..	1,704

Total .. 1,175,914

CLIMATOLOGY.

The climate of Bombay may be generally defined as fairly equable. Neither the variation of temperature from month to month, nor the fluctuations which occur from day to day are by any means large. The daily 'variability' of temperature which has a marked influence on organic life is fairly small, a result mainly due to the proximity of the sea and the presence of large quantities of aqueous vapour in the atmosphere. This however renders the climate even during the winter months relaxing rather than invigorating, and during the summer months strangers are apt on that account to denounce it as that of a Turkish bath. The prevalence during the winter months of the comparatively cold dry east winds brings no advantage as the winds blow over the land and can hardly be so fresh and free from germs of diseases as those which come from over the sea.

The divisions of the year into the seasons is appropriately made into two—the dry and the wet monsoon seasons. These are determined by the great systems of wind the north-east and the south-west monsoon which prevail alternately during the year from October to April and May to September respectively over a wide area including the Continent of India and the Indian Ocean.

The mean annual temperature is $79^{\circ}.6$. The fluctuations in the annual means do not exceed $1^{\circ}.4$ at the outset. The greatest maximum temperature $81^{\circ}.0$ was recorded in the year 1865 and the lowest minimum $78^{\circ}.3$ in 1866 and 1874. The mean variability of the annual mean is $0^{\circ}.5$. May is the warmest month in the year with a mean temperature of $84^{\circ}.7$. While for January which is the coldest month the mean temperature is $73^{\circ}.9$. The seasonal variation of temperature which until May follows fairly closely the course of the Sun and varies with the zenith distance is interrupted by the gradually growing intensity of the south-west monsoon current and the upward tendency being arrested the temperature from July to October continues almost within $1^{\circ}.6$ of the mean of the year, and the daily range also is markedly reduced. A slight rise in October is recorded

after the recession of the monsoon current after which the march of the temperature duly follows the season. It falls till January and begins to rise thereafter till May or June. The extreme maximum temperature recorded for the month of January was $77^{\circ}.3$ in 1865, while the extreme minimum was $71^{\circ}.1$ in 1874. The notable maximum mean temperature for the month of May—the hottest month in the year—was $87^{\circ}.6$ in 1865, the minimum recorded being $82^{\circ}.7$ in 1866. The coldest time of the day is about sunrise, 6 a.m., and the warmest at about 2 p.m. The periodic diurnal range is greatest in December and January when it is about $10^{\circ}.7$ and least in July when it is only $2^{\circ}.9$. The average daily variability during the year is $0^{\circ}.76$. It is $0^{\circ}.96$ in June and $0^{\circ}.88$ and $0^{\circ}.84$ in January and February. This change of temperature from day to day is least in May about $0^{\circ}.42$ which is generally the healthiest month in the year. The average annual rainfall at Colaba is 71.06 inches. The maximum fall recorded is 114.89 inches in 1849. The record minimum falls being 35.90, 33.42, 33.36 and 35.54 inches in 1899, 1904, 1905 and 1918 respectively.

The average date of the arrival of the monsoon on the Bombay Coast is 6th June. The extreme limiting dates between which the earliest beginning and the latest ending of the south-west monsoon current are likely to fall may be definitely laid down as the 1st May and 27th October. If a day is considered as a rainless day when less than one cent has been registered, the ratio of rainy days to the total number of days in the month may be taken roughly to express the probability of a day being rainy in that month. On the average this probability in June, July, August, September and October is represented by .70, .90, .85, .64 and .15 or in other words out of every 10 days there is a probability of 7, 9, 8, 6 and 1 day being rainy in these months respectively. The average monthly rainfalls of these months are 19.87, 24.50, 13.15, 10.43 and 1.88 inches.

The seasonal changes in humidity show that the lowest humidity 0.668 (1.000 denoting saturation) is reached in December. It keeps fairly uniform till February and rises thereafter till July when the maximum value 0.867 is attained. During the monsoon months this high humidity prevails steadily throughout till September. The cessation of the monsoon rains reduces this value which in October stands at 0.783 and thereafter it falls attaining its minimum value in December. The air is drier in the afternoon hours and most humid in the early morning hours. This relative difference is much less pronounced during the monsoon months. It is greatest in December when at 2 p.m. the humidity is only 0.554 and at 6 a.m. it is 0.763, while in July it is least—the respective figures being 0.841 and 0.895.

The prevailing direction of the wind is west-north-west, the oscillations of which about the mean position reach to the N.-N.-E. about December and to the S.-W. in June. The average velocity during the year is 8.7 miles per hour. The maximum velocity is attained in July when it is about 13.8 miles per hour. It decreases steadily and attains its minimum value 6.8 in October. It rises steadily thereafter to 8.1 miles per hour in March, falls slightly in May to 7.8 and rises suddenly thereafter reaching its maximum intensity in July. The prevailing direction of incidence of the local, land and sea breezes are W.-N.-W. and E.-N.-E.

N. A. F. Moos.

ARCHÆOLOGICAL.

The Bombay Castle.—Hidden among the trees behind the Town Hall and surrounded by old ramparts is the Bombay Castle, probably the oldest building in Bombay. It was the Manor House of Garcia da Orta, the celebrated Portuguese physician and botanist to whom "Bombaim" was rented in perpetuity in 1538. The house which was originally built by Garcia da Orta himself was known as Quinta and was in his time surrounded by a beautiful garden planted by the great botanist. This "Great House" which subsequently served as a Warehouse, Priory and Fort to the Portuguese was partially burnt by the Dutch and the English in 1627, but was rebuilt and better protected and still formed the residence of the Lord of the Manor. It was again partly destroyed by the Arabs of Muscat, and when Humphrey Cooke took possession of the island from Donna Iñez de Miranda, the proprietress of the Manor of Bombay in 1665 "there was little more than the walls" left of the Manor House. It was, however, put right; Aungier rebuilt the fortifications around it, and the "Bombay Castle" then became the Governor's residence. All Government Resolutions and Orders are addressed even to this day from "Bombay Castle." It was also known as the "Fort House" and now faces the visitor as he enters the gateway of the Old Arsenal and is marked as the "Pattern Room." The gateway was built by the Portuguese. An interesting relic in the Castle is "a long vault high enough for a man to stand in upright, and was probably used as a dungeon. It is a perforation of some twenty feet in length ending in a dead wall; there are no air holes or light admitted except by the door." The prisoners confined in it must have heard the sea moaning outside as in the dungeons under the Doge's Palace at Venice where one is told to listen to the waves of the Adriatic. Another interesting relic is the Sun Dial; it is ten feet high and embellished with much grotesque carving. The gnomon is gone but the figures are still distinct. It is said

to be "the oldest sculptured work in Bombay belonging to the period of the Portuguese occupation."

The City Ramparts and Fort George.—Bombay when it was ceded by the Portuguese was practically unprotected, the old Manor House being nothing but bare walls surrounded by an equally dilapidated rampart. It was therefore in constant danger of being attacked from land as well as from the sea; the Portuguese, the Marathas, the Sidi Admirals, Angria's ships, and the Pirates John Evory and Captain Kidd constantly menaced the island. The houses of the inhabitants living outside the Castle were not surrounded by any protective rampart walls, and Aungier therefore advised the enclosure of the town from Mendham's point on the west to Dongari point on the east where a small Portuguese fort already existed. The City wall, however, was not completed until 1716. Starting from a point to the east of the bungalow of the Director of the Royal Indian Marine the wall extended along Rampart Row, then known as the "Rope-walk," and passing the Esplanade and Hornby Roads turned eastwards and stopped at Mody Bay near Fort Street. These fortifications were extended and strengthened in 1736. In 1739-1743 a ditch was constructed around these ramparts and between 1746-1760 extensive additions were made in the shape of bastions and batteries. The fortifications were still further improved in 1769 and the little Dongari Fort which until then was used as a prison for debtors and criminals was demolished and in its place Fort George was built on a larger scale.

Fort George.—Fort George, named after King George III, stood outside the Bazaar Gate on a slight eminence called "Dongari," and although it was a small fortified place it overlooked the Castle proper, and was therefore strategically very important. It was demolished along with the fort ramparts (1862-1864) but the remnants of its walls may still be seen in the grounds of St. George's Hospital.

The city ramparts—if the marine gates be excluded—were provided with three gates. Of these the *Apollo Gate* faced the south and stood near St. Andrew's Church. The *Church Gate* stood near the present Flora Fountain, and was the main and fashionable gate of the city. The *Bazaar Gate* stood near the north end of Bazaar Gate Street, and was the most frequented gate, being chiefly used for bringing supplies into the city.

The old ramparts of Bombay, and the city gates were demolished in 1862-64. They were found to be useless for purposes of defence, they interfered with the free circulation of air, and the ditches harboured "stagnant and foul" water. The space thus set free was laid out in roads, open places and public buildings. No remnants of the city walls are now in existence.

The old Secretariat.—This building stood in Apollo Street on the site of the present "Sardar Palace building." Before 1757

the Governor resided in the "Fort House," but in that year Government purchased "Mr. Spencer's House" in Apollo Street and transformed it into Government House. It was described as "a handsome building with several good apartments"; Governor Jonathan Duncan died in it in 1811. In 1829 it was converted into the Secretariat, and the Governor's residence removed to Government House at Parel. It remained as Secretariat until 1873, and even after the removal of the Secretariat from it to the present new building on the Esplanade, was for a long time known as the "Old Secretariat." It was sold by Government in 1886.

Hornby House.—The Great Western Hotel Building has a historic past, but its date of building is not known. In 1754 it belonged to Mr. Hornby, who afterwards became Governor of Bombay, 1771-1784, and was consequently known as Hornby House. From 1744 to 1770 it was used as Admiralty House and from 1786 to 1880 its main room was the Town Hall. From 1786 to 1788 the Mayor's or Recorder's Court occupied a back room in the building. In 1800 the whole of Hornby House was rented for the Mayor's Court and here in the large main hall—the former dining hall of the Hotel—Sir James Mackintosh, the Recorder of Bombay, sat and decided criminal and civil cases from 1803 to 1811. In 1824 the Recorder's Court was styled the "Supreme Court," which name in 1862 was changed into "High Court" and in 1879 it was removed from Hornby House to the present High Court building on the Esplanade.

Hornby Vellard.—This causeway which is about half a mile in length unites Cumballa Hill with Worli and was constructed by Hornby during his Governorship from 1771 to 1784. At the southern end of it, out in the sea lies the tomb of Haji Ali, a Muhammadan Pir, and at the further end of the Vellard on the point of the hill near H. H. the Maharaja Scindia's Palace stands the shrine of Mama Hajiyani. There are reasons to suppose that a causeway did actually exist in this place before Hornby constructed the present Vellard. Aungier in 1673 mentions a "breach" at Mahaluxmi "where the sea came in and inundated the island," but makes no allusion to any dam. By the gradual silting up of the creeks with highly putrescible matter deposited by the tides, the island gradually became so extremely unhealthy that when the Rev. J. Ovington, the Company's Chaplain, visited Bombay in 1689, he described it as "nought but a charnel-house." The excessive mortality of Bombay caused the greatest anxiety to the Court of Directors who constantly urged the necessity of stopping the breaches and reclaiming the low-lying area liable to be flooded. As a result of this Captain Bates constructed about the year 1720 a dam which checked the in-roads of the sea and rendered the central part of the island available for cultivation. In 1750 Grose wrote the following: "There

has always been another reason assigned for the island having grown healthier from the lessening of waters by a breach of the sea being banked off." In 1754 Edwards Ives wrote as follows: "The island of Bombay has of late been rendered much more healthy than it was formerly by a wall which is now built to prevent the encroachment of the sea where is formed a salt marsh." The existence of such a wall is actually shown in Niebuhr's map dated 1764, *i. e.*, nearly seven years before Hornby became Governor. Moreover, Dr. Buist, the Geologist, seems to have been aware that the Vellard was built before Hornby's governorship, for he tells us in an article on the Geology of Bombay which is published in the *Transactions of the Bombay Geographical Society*, Vol. X, 1852, that "the embankment between Love Grove and Mahaluxmi was completed about a hundred years before, *i. e.*, 1752, which it is said has contributed much to the improved health of the place." Under these circumstances the only conclusion which one can come to is that Governor Hornby only constructed a carriage road over a pre-existing dam, built nearly 50 years before his regime. The name Vellard is derived from *Vallado*, a Portuguese word, meaning an embankment. In 1747 a naval engagement took place off Hornby Vellard, "the only battle ever fought by the French and English on the western seas of India."

The Town Hall.—The necessary funds for the erection of the Town Hall building were originally raised by means of lotteries, but the amount proving insufficient, Government were asked to complete the work. The building was designed by Col. Cowper, R.E., and completed in 1833. A massive flight of stone steps on the west leads to a colonnade of large Doric columns which were originally intended to stand in pairs. The pediment is empty. The great main hall, the internal decorations of which are Corinthian, is used for public meetings, concerts and balls, and contains a large organ, the gift of Sir Albert Sassoon in 1872. Behind it is the "Durbar Room" which was formerly used for state purposes. The north end of the building is occupied by the *Bombay Branch of the Royal Asiatic Society* which has arisen from the Literary Society of Bombay founded by Sir James Mackintosh, Recorder of Bombay, in 1804 "for the promotion of literary and scientific investigations connected with India and the study of literature, antiquities, arts and sciences of the East." Since 1829 it has become an integral portion of the Royal Asiatic Society of Great Britain and Ireland. In 1873 the Bombay Geographical Society (established in 1831) was amalgamated with it. The Royal Asiatic Society's *Library* contains a large collection of rare old books and valuable manuscripts in Sanskrit, Prakrit and Gujarati. The *Museum* attached to the library was opened in 1816 and contains many valuable and interesting archæological relics. The museum of the Anthropological Society of Bombay was also located in this building (see Museums) but has been since removed to the

Prince of Wales Museum. A number of fine statues have been housed in the Town Hall ; these have been described in detail under the heading of " Statuary."

Old Government House, Parel.—This building was originally a Roman Catholic Church, but the date of its building is not known. The earliest reference to it is by Dr. John Fryer, M.D., who described it in 1674 as a church and convent belonging to the Jesuits. But there is reason to believe that there previously stood upon the site the Hindu Temple of Parali-Vaijnath built by the followers of Raja Bimbdev, and that it was from this temple that the district acquired its name of Parel. The temple was destroyed through the proselytising zeal on the part of the " Religious Orders " to whom this part of Bombay was given free of rent by the Portuguese Government. Fryer makes no mention of the Patron Saint of the Church, and the actual name of the church remains unknown to this day. It seems, however, that it was under the control of the Principal of the College of the Jesuits (St. Anne's) at Bandra who claimed it as their property when Bombay was ceded. On their claim being disallowed the priests threatened to resort to arms, and even went to the length of assisting the Sidi Admiral in his invasion of Bombay. Consequently in 1719 the Monastery and the lands at Parel were confiscated, and with suitable alterations the " Parel House " was used from 1720 for over a hundred years as an occasional residence by the Governors of Bombay. In 1829 it became the Government House and the permanent official residence of the Governor.

In 1750 Grose described it as " a pleasant mansion house and what with additional buildings and improvements of the garden affords a spacious and commodious habitation." " Here the Governor may spend most part of the heats, the air being cooler and fresher than in town ; and nothing wanting that may make a country retirement agreeable." Governor Hornby was the first to reside in the Parel House in 1776. In 1803 Sir James Mackintosh, the Recorder of Bombay, lived there ; he writes : " We inhabit by the Governor's kindness his official country house, a noble building with some magnificent apartments and with two delightful rooms for my library in which I am now writing, overlooking a large garden with fine parkish ground." The building was enlarged and embellished by Mountstuart Elphinstone (1819-27) ; it was he who built the right and left wings. Bishop Heber, in 1838, describes it as " very handsome having a fine staircase and two noble rooms one over the other of 75 or 80 feet long very handsomely furnished. The lower of these which is the Dining Room is said to have been an old and desecrated church belonging to a Jesuit College." The altar was in the room to the east of the Dining Room with an archway between. Recently (1913), while some structural alterations

were being carried out in this part of the building the archway which had been evidently filled in, could be distinctly made out and a faint smell of incense could be detected coming from the old beams and the exposed brickwork. The house was repaired during the time of Viscount Falkland and a tombstone erected by Lady Falkland over her favourite dog "Cuba" in 1852 is still to be seen in the back garden. In 1859 "on the landing place of the very handsome stone staircase stood a valuable marble bust of the Great Duke of Wellington." From 8th to 15th November 1875, H. R. H. the Prince of Wales (His late Majesty King Edward VII) occupied the end room in the first floor of the north wing of the building, but after the death of Lady Fergusson in 1883 from cholera the place was abandoned in favour of the house at Malabar Point. In 1897-98 the Old Government House was utilised as a Plague Hospital and in 1899 Mr. Haffkine's Plague Laboratory was transferred there; and was until recently known as the Bombay Bacteriological Laboratory. It is only this year that the Laboratory is renamed the "Haffkine Institute." Lately a scheme was under consideration for making extensive additions to the buildings, and equipping it as a School of Tropical Medicine.

Of the past glories of the Old Government House, a faint idea can be had from the main staircase and the decorated walls and ceiling of the old Ball-room. The garden at the back of the house which at one time was "very spacious and well looked after" has completely disappeared, and a prosaic cricket field occupies the place. The large tank at the back of the garden, "that beautiful sheet of water" which at Jonathan Duncan's grand ball to Arthur Wellesley and his staff, "became a fairly scene of gorgeous fireworks which blazed away far into the night and early morning over the faces of fair women and brave men", is now forgotten.

ARCHITECTURAL NOTES.

St. Thomas Cathedral.—The Cathedral was commenced in 1715 and completed in 1718. The structure consisted of a central nave with side aisles and a semi-circular apse at the east end. The nave arcading is supported on massive circular pillars to carry the heavy masonry vault which forms the roof. The work is of no particular architectural interest although the Secretary to Government wrote on Christmas Eve two hundred years ago that it was "a structure deservedly admired for its strength and beauty, neatness and uniformity, but more especially for its echo." The present tower was added in 1838 and again in 1865 a new chancel and organ chamber were built in Gothic character and obviously begun with the intention of reconstructing the entire Cathedral on the same lines. On the walls there are a number of interesting monuments and tablets.

The Mint.—The Mint was originally completed about 1827 but has had many additions and alterations since. The west front of the main block is curiously pinched and narrow in appearance; it has something of the renaissance in its character but little regard for proportion or composition.

St. Andrew's Church.—St. Andrew's Church of the Scotch Kirk stands near the old Apollo Gate to the fort. It was erected in 1818 and is a simple building on classical lines with a pleasing spire.

The Town Hall.—The building was commenced in 1821 and completed in 1833. It is a fine broad composition strongly influenced by the Greek revival. The building consists of a basement containing various offices with the hall proper over. A very fine flight of steps gives access to the hall from the main road. The northern wing houses the library of the Royal Asiatic Society. There are some interesting pieces of sculpture in the Hall and staircase.

The Secretariat.—This building is a Gothic structure erected in 1874. It is very inconveniently planned for its purpose as an office building while the exterior is mean and suggestive of being patched together.

University Buildings.—The University Hall at the southern end of the University gardens was designed by Sir Gilbert Scott and completed in 1874. It is a spacious chamber with galleries, covered by a fine vaulted roof of Porebunder stone. The treatment is Gothic founded on early French work.

The Rajabai Tower and the University Library.—This group was also designed by Sir Gilbert Scott and is similar in character to the work of the University Hall. The Library is two storeys in height with Reading Room in the lower floor and the Library above, which is a fine room with a handsome timber ceiling. The Rajabai Tower rises in front of the Library to a height of 250 feet and throws the other buildings entirely out of scale. The Tower forms a prominent landmark from a distance, but the grouping is not happy when viewed in conjunction with the adjacent buildings. This tower terminates in a somewhat unsatisfactory manner, great octagonal corner buttresses run up the entire height and finish in a feeble parapet from inside which an octagonal lantern rises without connection or relation to the mass of the tower.

Telegraph Office.—The Telegraph Office now includes the building to the south which was originally put up in 1872 as a General Post Office. This latter is a very charming composition externally, but is sadly lacking in all the essentials of a busy public office internally and the same may be said of the original telegraph office which is situated to the north of the old Post Office.

Sailors' Home.—The Royal Alfred Sailors' Home, of which the foundation stone was laid by the Duke of Edinburgh, was opened

by Lord Lytton, then Viceroy of India in 1876. It occupies a very fine site and forms a quaint and interesting Gothic group somewhat marred by an evil practice of periodically whitening the Porebunder stone work of the central gable.

The High Court.—The High Court was erected in 1879 and is a massive Gothic pile facing Mayo Road. In effect it is heavy and somewhat uninteresting and the internal arrangements are cramped and dark.

Public Works Secretariat.—This is another Gothic building with something of a Venetian flavour. It was begun in 1869 and completed in 1872 and a western wing towards Mayo Road was added later. The planning and internal office arrangements are bad, very little consideration having been given to the purpose it had to serve.

Victoria Terminus.—This group consists of a central station and administrative offices completed in 1888. It is designed in an ornate Gothic manner which appears to appeal to many. The station proper is cramped and inconvenient.

Municipal Buildings.—The Municipal Buildings were opened in 1893. The structure occupies a triangular site, is Gothic in general treatment with Indian domes surmounting the Gothic towers. The group is dominated by a great central mass which is inclined to dwarf the remainder of the work. Inside there is a fine central stair-case and handsome Council Hall.

B. B. & C. I. Railway Offices.—This group of buildings is situated at the junction of Queen's Road with Marine Lines where it occupies a triangular site. It was designed by the late Mr. F. W. Stevens and completed in 1899. The style is a mixture of Gothic and Indian elements, but the general composition is very pleasing especially from a distance when the various features group with the central tower in a very satisfactory manner.

The General Post Office.—The New General Post Office was designed by Mr. J. Begg, and completed in 1911. The building consists of a partial basement, ground and three upper floors. The plan is arranged round a central hall which is carried up through the building and covered by a dome. All the public departments are reached from this central hall which ensures directness and convenience of working. The rooms throughout are airy and well lighted. The treatment of the building is founded on the Muhammadan work in Bijapur during the fifteenth and sixteenth centuries.

Prince of Wales Museum of Western India.—The foundation of this Museum is the outcome of His Majesty's visit to India as Prince of Wales in 1905. It was opened on the 10th January 1922 by Lady Lloyd. The building is two storeys in height. The work is of Indian character and was designed by Mr. G. Wittett.

The Royal Institute of Science.—The Royal Institute of Science occupies a corner site at the junction of Mayo Road with Esplanade Road. It includes several units, the science college, a science library, a public hall and a block of examination schools; the science college occupies the western and the southern wings with the library in the rear, the public hall is located at the angle of the site and the examination halls form the eastern wing facing Esplanade Road. The public hall is circular in plan with a diameter of 80 ft. The platform forms a chord of the circle. There are two galleries and the building is designed to seat over one thousand people. The group which is treated in a simple renaissance manner with well balanced masses was designed by Mr. G. Wittet, F.R.I.B.A.

* *Gateway of India.*—This monument at Apollo Bunder, built to commemorate the landing in India of Their Imperial Majesties in December 1911, was declared open by H. E. the Viceroy, Earl of Reading, on 4th December 1924. The land on which it stands was reclaimed specially from the harbour between the years 1915 and 1920. The building is founded on reinforced concrete piles 36 feet long, driven to rock, and is constructed of yellow basalt stone from the Kharodi quarries in the Thana District. The domes and galleries are of reinforced concrete, the central dome being 48 feet in diameter and 83 feet above pavement level at its highest point. The Gateway, which is ordinarily open to the public, will be used for reception purposes on the occasions of ceremonial landings and departures and is calculated to accommodate 600 persons. The design is Indian in character based on the traditional architecture of Western India. The architect for the lay-out and the building was Mr. G. Wittet, F.R.I.B.A. The sea-walling and reclamation works were carried out by the Bombay Port Trust and the building itself was constructed by the Public Works Department.

STATUARY.

BOMBAY possesses a number of fine statues scattered throughout the city, adorning either its public squares and gardens or the interior of its great buildings, museums and charitable institutions. The majority of these statues are from the studios of some of the most distinguished sculptors, while others are very indifferent productions.

The oldest statues are those located in the Elphinstone Circle Garden. The monument for the Marquis of Wellesley was originally received in Bombay about the year 1814 but was not actually erected until 1825. "The statue was suffered to be neglected for years after its arrival in the warehouse of Messrs. Forbes & Co. and it was with the greatest difficulty and only through the influence and liberal contributions of Sir Charles

Forbes that money was raised to put it in its place." The Marquis, who is seated, holds a book in one hand and is presenting a bracelet to an athletic Maratha sepoy with the other. A female figure balances the group and a lion and lioness at the back form decorative accessories to the pedestal. In the same garden stands also an attractive memorial to Marquis Cornwallis, put up in 1824. The Marquis is represented standing upon a pedestal supported by two female figures, one representing Wisdom and the other Integrity. Both these groups were to have been modelled by Flaxman, but the work was for some unknown reason entrusted to Bacon. A third statue in honour of Pitt, which was also subscribed for along with these statues, does not appear to have ever been received in Bombay. These valuable statues which cost nearly £20,000 sterling need to be removed from their present out-of-the-way sites, and placed in more suitable and sheltered places, and protected against further ravages from exposure and rain.

The Town Hall which was built "among other purposes for the reception of the statues of Marquis Cornwallis, Mr. Pitt and any future monuments of British Art which public gratitude may bring to Bombay," contains a good collection of statues by celebrated sculptors. In the main hall is a fine statue by Chantrey of Mountstuart Elphinstone, Governor of Bombay, from 1819 to 1827. In the south vestibule there is another specimen of Chantrey's work, *viz.*, a statue of Sir Charles Forbes, Bart., a "disinterested benefactor and the tried and trusted friend of the people of India." The northern wing of the Town Hall which is occupied by the Bombay Branch of the Royal Asiatic Society, contains a number of fine statues. Near the main stairs of the Library on the ground floor is a statue of Jagannath Shankarshett, by Noble, erected in 1864 by the inhabitants of Bombay as a "tribute to one of their most illustrious fellow-citizens." At the top of the staircase is a statue of Sir John Malcolm, Governor of Bombay, from 1827-1830; it is another piece of fine work by Chantrey. In the north-east corner is another statue by Chantrey, *viz.*, of Judge Babington, who revised the Judicial Code. Near by is a statue of Lord Elphinstone, Governor of Bombay (1853-1860), by Foley. On the opposite side is a statue of Sir Bartle Frere by Woolner, who has fairly well succeeded in marking the most of an inartistic attire; in the corner close by is a statue by Theed of Charles Norris of the East India Company "whose labours in the judicial department were most useful to Government." He is seated clad in a Roman toga. Next to him and sitting dressed in full Parsi costume is a statue of the first Sir Jamsetji Jijibhoy by Marochetti; it was put up in 1858. In the Library's Meeting Room close by is a bust of Sir James Rivett Carnac, Governor of Bombay. This bust, which is not at all well finished, "was

subscribed for in 1841, and arrived in Bombay in 1846, lay for three years in its packing case under one of the Town Hall stairs and was only discovered by accident." Murray (1859) states that the bust of Carnac was by Chantrey. The bust in the Meeting Room is by Macdowell, and if it had still remained in its packing case it would hardly have been much of a loss to Bombay. According to Murray there was also a bust of Sir James Mackintosh in the Library, but it is not there now. Bombay has neither a bust nor a portrait of this great scholar—"the most splendid character in the whole range of Bombay history—made to love and to be loved with a transparent intellect that shed an electric light on everything it touched, and an imagination that soared far above the common level of mortals."

By far the largest majority of statues are to be found in the Fort district. St. Thomas' Cathedral contains some exceedingly handsome memorials. There is a fine monument by Bacon to Jonathan Duncan who for 16 years was Governor of Bombay; he abolished "infanticide in Benares and Kathyawad" and died in Bombay in 1811 in the old Governor's House in Apollo Street. Forbes' tribute to him is as follows: "thousands of happy mothers in all succeeding ages while caressing their infant daughters will bless the name of Duncan." Another fine memorial by Bacon is to Captain Hardinge who fell in a naval engagement off Ceylon. The other notable monuments are—to John Watson who was killed at the Siege of Thana, to Admiral Maitland to whom Napoleon surrendered on board the *Bellerophon*, and to Major Pottinger, the hero of Herat. Bishop Carr's effigy in full episcopal robes lies in the south transept, and Mrs. Kirkpatrick has also a very fine memorial by Bacon. The monument to Babington is by Chantrey in his best style.

A bronze statue by Wade of H. M. King George V in naval uniform stands in the garden of the Prince of Wales' Museum, and is a poor production. The panels on the pedestal represent the laying of the foundation stone of the Museum and the reading of the address of welcome by the Municipal Corporation. In the open space to the north-west of the building is a fine equestrian statue of the late King Edward VII by Boehm. The granite base bears two panels, one showing the Indian Princes being presented to His Majesty by the Viceroy Lord Northbrook, the other, school girls of Bombay presenting the Prince with flowers. This statue was given to the city by Sir Albert Sassoon. In the Sassoon Mechanics' Institute close by there is a fine marble statue of David Sassoon by Woolner, and also a bust of James Berkley, the Engineer.

In the University Garden in front of the Cowsaji Jehangir Senate Hall there is another statue by Woolner, *viz.*, that of Sir

Cowasji Jehangir, and to the east is Mossman's statue of Thomas Ormiston, who constructed the Prince's Dock and built the Lighthouse at Prongs. Both these statues appear to be lacking in graceful lines. The University Library building contains busts of Sir Bartle Frere by Woolner, of Gibbs by Belt, of Fawcett by Hope-Pinker and a bronze bust of Sir George Birdwood, holding an image of "Dattatraya."

* Looking towards the Gateway of India at Apollo Bunder there is a handsome bronze statue by Herbert Hampton of Lord Hardinge of Penshurst, Viceroy 1910-1916.

On the oval near the south-east corner stands a marble statue by Brock of the great educationist and social reformer, Sorabji Shapurji Bengalee and on the opposite side of the road is Mhatre's statue of Justice Ranade. At the north-east end of the Oval stands a statue of Sir Richard Temple, Governor of Bombay (1877-1880), by Brock. To the west of it is a fine bronze statue by Alfred Gilbert of Lord Réay seated dressed in the robes of the Chancellor of the University of Bombay, and further west is a statue of Lord Sandhurst, an inartistic piece of sculpture.

* Just opposite, on the other side of Church Gate Street, is the seated statue, in bronze, by Reccare of E. S. Montague, late Secretary of State for India, and a few yards to the east is Mhatre's statue in white marble of the great Indian statesman and patriot, Gopal Krishna Gokhale, who founded the Servants of India Society. At the junction of Mayo and Esplanade Roads is Noble's fine statue of Queen Victoria erected in 1872. Her Majesty, clad in royal robes, is seated under an exquisitely carved canopy of Gothic Architecture; it was originally intended to be a companion statue to that of Prince Consort in the Victoria and Albert Museum in the Victoria Gardens.

A few statues have been erected near the Municipal Offices. *In front of the main entrance stands a fine bronze statue by Wood of that famous citizen, Sir Pherozeshah Mehta, who was for many years the most prominent member of the Bombay Municipal Corporation. On the border of the circular green to the south of the Victoria Terminus station and facing Hornby Road is a seated marble statue of the "great philanthropist and captain of industry," Sir Dinshaw Maneckji Petit, the first Baronet by Brock, and near the junction of Cruickshank and Waudby Roads is a memorial group in bronze by Colton to the "pioneer of Indian industries" Mr. J. N. Tata. The "great patriot and philanthropist" is represented as seated with two small allegorical figures in front...., "Industry," as represented by a nude cooly straining at cotton bales, while a semi-draped female figure represents "Science"; the winged figure overhead with a laurel wreath represents "Fame." The general effect of the grouping is scarcely satisfactory. The heavy

overhead figure, like the winged Victory of Samothrace with her drapery blown about by the wind, does not harmonize with the two little allegorical figures placed below. - Further north is a marble statue of Dr. Blaney by Valla, an indifferent piece of sculpture ; if this statue were mounted on a much higher pedestal the foreshortening effect would certainly go a great deal towards modifying its obvious defects.

The Council Hall of the Municipal Offices contains a number of busts. Roscoe Mullins is represented by busts of Sir Charles Ollivant, the Municipal Commissioner, and Sir Frank Souter, the Commissioner of Police. The other busts, *viz.*, of the late Queen Victoria, Dr. Blaney and Rao Saheb Mandlik are by the Bombay School of Art. There are also busts of Acworth, Harvey, and Captain Henry.

* Two marble busts are to be seen in the Royal Institute of Science—one by Mhatre of Sir Vassanji Tricumji in the library with which his name is associated and the other by Brock of Sir Cowasji Jehangir at the entrance to the Public Hall which was built from funds donated by him.

A few pieces of sculpture are located in the Victoria and Albert Museum in the Victoria Gardens. In the main hall there is a very fine marble statue of Prince Consort by Noble. The Prince is standing on a pedestal at the foot of which are two graceful figures representing Science and Art. This memorial contrasts very favourably with those marble statues and monuments which have been put up in various open places in Bombay and allowed to get damaged through exposure to the local climatic conditions so detrimental to these valuable treasures of Art. There are two more specimens of Noble's art here, *viz.*, the busts of Lord Canning and Mountstuart Elphinstone. The marble bust of David Sassoon is by Woolner, and in the entrance hall there is a plaster bust of Lady Frere. The original of the latter by Woolner was placed in a small Graeco-Roman temple in the Victoria Gardens, but was unfortunately damaged beyond repair in a thunderstorm ; the plaster replica has been presented by Lady Frere's son. A plaster replica of the bust of H. M. King Edward VII is to be seen at the top of the staircase.

In the J. J. Hospital there is a large bronze statue of the first Sir Jamsetjee in full Parsi costume, and in the adjoining Grant College library may be seen busts of Morehead, Ballingall, Peet and Haines, former Professors in the Medical College ; Doyle Jones' bust of Dr. Cowas Lalkaka is also placed here.

In this chapter we will also describe some of the Ornamental Fountains which are to be seen in Bombay. The Wellington Memorial Fountain lies to the south of the Prince of Wales' Museum and was erected in 1865 as a memorial to the Duke of Wellington, who as Sir Arthur Wellesley actually resided in

Bombay in 1801 in a house, now demolished, at the foot of Malabar Hill, and again in 1804 in tents on the Esplanade. The Flora Fountain which stands at the junction of Esplanade Road and Churchgate Street was erected about the year 1866 in honour of Sir Bartle Frere, Governor of Bombay from 1862-1867. The fountain in the Cathedral compound is a gift of Sir Cowasji Jehangir, and an ornamental fountain is also located in the Elphinstone Circle. The fountain at the junction of Frere and Mint roads is a comparatively new structure and was built in 1894 by Mr. Ratansi Mulji in memory of his son whose statue it bears. A fountain with clock tower in the Assyrian style of architecture stands in Bazaar Gate Street, and was erected in 1880 in memory of Mr. Bomanji Wadia whose statue by Westmacott in 1865 graces its interior. The Fitzgerald Memorial fountain and lamp, which stands at the junction of Cruickshank and Esplanade Roads was erected in 1867 to the memory of Sir Seymour Fitzgerald, Governor of Bombay, from 1867 to 1872. The Crawford Market contains a Fountain designed by Mr. Lockwood Kipling, father of Sir Rudyard Kipling, who also sculptured the two decorative panels on the main entrance of the market buildings. Sir Rudyard himself was born in Bombay in a bungalow on Chichpokli Hill, now demolished. A fountain erected about the year 1864 at the junction of Bellasis and Duncan Roads at Byculla stands in memory of Shet Cursetji Maneckji Cursetji whose bronze statue crowns its Corinthian pillar. "He was in his time a great figure in Parsi life as the head of the old Panchayet and was much esteemed by Parsis, Hindus and Mussalmans for his many useful services." It was in his house at the foot of Malabar Hill that Sir Arthur Wellesley resided during his stay in Bombay before the Assaye campaign. The fountain in the centre of Jacob's circle has been erected to the memory of General Legrand Jacob.

PLACES AND OBJECTS OF INTEREST.

BOTANICAL AND ZOOLOGICAL.

Bai Sakarbai Dinshaw Petit Hospital for Animals.—This hospital is situated at Parel a little to the south of the Old Government House, and owes its origin to the Bombay Society for the Prevention of Cruelty to Animals. It was opened in 1884 and contains Wards for Horses, Cattle and Dogs; all classes of animals are treated both as indoor and outdoor patients.

Attached to the Hospital is the *Government Veterinary College* which trains students as veterinary practitioners. It has a large Museum, Library, Pharmacy, Shoeing Shed and Chemical and Pathological laboratories.

Pinjrapole.—This is an asylum for decrepid animals, and is situated in the heart of the city at Bhuleshwar. The institution was founded in 1834 by the Hindu and Parsi Communities of Bombay and contains a large number of horses, ponies, cattle, dogs, goats, buffaloes and other animals; medical treatment is provided for diseased animals.

Natural History Society. (See Museums.)

Victoria Gardens.—These gardens are situated on Parel Road near the Byculla Railway Station, they were originally laid out by the late Sir George Birdwood in 1861 on what was then a "useless and low-lying" piece of land and stocked with plants from the Agri-Horticultural Society's Garden at Sewri, the latter being converted into a Christian cemetery: Since 1873 the Victoria Gardens have belonged to the Bombay Municipality.

The entrance is near the David Sassoon Clock Tower which has a fountain. Close to the entrance is the *Victoria and Albert Museum* (see Museums). To the east of the building is a massive stone elephant lately restored; it originally stood on the southern shore of the island of Elephanta. Beyond it is the triple-arched gateway, the entrance to the gardens proper. The gardens are well laid out with broad paths, raised terraces, ornamental ferneries, and miniature lakes, and contain many choice and rare species of tropical trees and plants. (See article on "Some Interesting Economic Plants in the Victoria Gardens.") The Zoological collection comprises all kinds of living mammals, birds and reptiles. Among the collection there are wild donkeys and some rare animals such as the Panda or Cat-bear (*Ailurus fulgens*) from Nepal, and an Albino variety of the Rib-faced or Barking deer (*Cervulus muntjac*). The Superintendent, Mr. Doctor, succeeded in breeding some Rheas, and also a Zebra. This is believed to be the first instance of Zebras breeding in India.

CEMETERIES.

Christian.—The first English cemetery in Bombay was on or near the site of the present Sailors' Home, and was known as *Mendham's Point*, possibly named after the first man buried there. In 1760, however, strategic reasons forced Government to demolish it along with other structures opposite the old Apollo Gate. A new site for burial was then selected on the Chowpatty foreshore near the Hindu Burning Ghat and the old Portuguese Cemetery at Sonapur; and it was in use from 1763 until 1867, when the present cemetery was opened at Sewri. Christian burial grounds also existed at Matunga, Marine Lines and at Colaba Point, but these also have been closed for burial.

The Sewri Cemetery was originally a botanical garden of the old Horti-Agricultural Society, but was purchased and laid

out as a cemetery for Protestants, Roman Catholics and Presbyterians, consecrated and opened in 1867.

The Hindu Burning Ghat at Sonapur, on Queen's Road, has been in use as such from the year 1677 when Aungier gave permission to the Banias from Diu to burn their dead on the Back Bay Sands. The place was probably walled in when Queen's Road was constructed. Cremation is carried out in a crude manner. No proper crematoria for the disposal of the Hindu bodies exist in Bombay. A small crematorium which was erected in the compound of the Acworth Leper Asylum at Matunga sometime ago, and which was worked with success, has now fallen into disrepair.

Muhammadian burial places also exist along Queen's Road.

Parsi Tower of Silence. The Parsi custom of disposing of the dead is over three thousand years old and the places specially built for the purpose are known as the Towers of Silence. They are all situated in an extensive piece of ground on the highest part of Malabar Hill to the west of Gibb's Road. The grounds contain five towers. Of these the oldest, known as the Modi Tower, was built by Modi Hirji Wachha, one of the earliest Parsi settlers, about the year 1673; the second oldest tower was built by Maneckji Seth about 1751. These two towers bear no inscription. The third known as the Anjuman's Tower was built in 1779 and bears an inscription in Persian. The remaining two, known as Framji Banaji's Tower and Cowasji Bisni's Tower, were consecrated in 1832 and 1844, respectively and bear inscriptions in Gujarathi. Each tower is a round massive stone structure with a raised wall. A few steps from the ground lead to an iron gate which opens on a circular platform having three graduated rows of shallow receptacles for receiving the bodies, the outermost for men, the middle for women, and the innermost for children. In the centre there is a large well. The vultures do their work expeditiously and within a very short time only the bones are left, which when perfectly bleached by the powerful action of the tropical sun, are thrown into the well where they gradually crumble into dust. Four underground drains carry off the rain water from this well through filters of charcoal and sand-stone into subterranean wells provided with a thick layer of sand at the bottom, so that all water passing over the bones is thoroughly filtered before it enters the ground. Smoking is strictly prohibited within the premises and cameras should not be taken inside. The necessary passes for admission are issued by the Secretary of the Parsi Punchayet.

CLUBS AND GYMKHANAS.

The Byculla Club is situated in the Byculla district on Bellasis Road. It is the oldest club in Bombay, and was founded in 1833 when it was established in its present quarters, part of

which originally formed the "Byculla Assembly Room" and was used as a grand stand for the Byculla races. The crest of the club represents the Byculla Turf pavilion as it existed in the year 1814. The club garden contains several rare plants and trees.

The Bombay Club is situated on Esplanade Road, and has arisen out of the old Indian Navy Club whose relics in the shape of a Burmese bell and several candelabra it still possesses.

The Royal Bombay Yacht Club.—Boat racing was in vogue in Bombay as early as 1839, but there was no club house until 1881. The present building which is situated on the Apollo Bunder reclamation was opened when Captain (afterwards Sir Henry) Morland was the Commodore of the Club. The Club and its yachts have the permission to fly the Blue ensign of the Fleet. The residential quarters in connection with the club are situated on the opposite side of the Apollo Bunder Road.

The Orient Club was opened in 1900 for encouraging intimate relations between European and Indian gentlemen. It is located at Chowpatty in a building of its own, opened in 1910.

The Willingdon Sports Club.—This club, which is located near Hornby Vellard, lies to the south of Clerk Road upon a large piece of low-lying ground reclaimed by filling it up with road sweepings of Bombay. The extensive club grounds with an area of 35 acres are laid out for all kinds of outdoor sports and games; the pavilion which stands upon a large terrace commands a good view of the play-fields and a fine polo ground. The club was opened in 1917 and has both Europeans and Indians as members, and is conveniently situated near the Race Course; but breezes from Love Grove, and the dust laden atmosphere of the surrounding flats go a great deal towards spoiling the attractiveness of this club.

Gymkhanas.—The Bombay Gymkhana for European residents is situated at the junction of Esplanade and Waudby Road. The Parsi, Hindu, Islam, Catholic and German Gymkhanas are all located along Queen's Road between it and the Back Bay; the last named was converted early in the war into a Volunteer Club. The Commercial and Japanese Gymkhanas are near the Cooperage. The Ladies' Gymkhana is on Malabar Hill and the Princess Victoria Mary Ladies' Gymkhana which has both European and Indian ladies among its members is also near the Cooperage.

EDUCATIONAL INSTITUTIONS.

The University of Bombay.—The University was established in 1859, and was originally modelled as an examining body on the lines of the University of London; its constitution however was considerably modified in 1904. The University Senate

consists of the Chancellor who is generally the Governor of Bombay, a Vice-Chancellor and Fellows. The Senate is divided into four faculties, *viz.*, Arts, Science, Law, and Medicine. The following Colleges in Bombay are recognised by the University in the different faculties :—

In *Arts*—Elphinstone College, Wilson College, St. Xavier's College, the Sydenham College of Commerce and Economics and Secondary Teachers College ; in *Law*—the Government Law College and in *Medicine*—Grant Medical College and the Seth Gordhandas Sundardas Medical College.

Elphinstone College.—This is the principal Government Arts College in the Presidency and has been located in its present building in the Fort since 1888 after several changes of situation. It was originally the outcome of a meeting of the citizens of Bombay held in 1828 to decide upon a suitable memorial to the Hon'ble Mountstuart Elphinstone, Governor of Bombay from 1819 to 1827, and esteemed as "father and friend." The following resolution was passed at the meeting : "that the most satisfactory and durable plan of carrying their public wishes into effect is by accumulating a fund of money to be vested in Government securities, from the interest of which, according to its amount, one or more Professorships (to be held by gentlemen from Great Britain until the happy period arrives when the natives shall be fully competent to hold them) be established under the Bombay Native Education Society, for teaching the English language and the arts and sciences of Europe ; and that these professorships in compliment to the person in reference to whom the meeting has been convened, be called the Elphinstone Professorships." In 1835 the "Elphinstone Institution" was constituted and in 1836 Professors were brought from Europe for teaching purposes. In 1855 the late Mr. Dadabhoj Navroji was appointed the first Indian Professor of Mathematics, and in 1856 the institution was divided into a College for the higher studies, and a School for the lower standards. The college was recognised by the University of Bombay in 1860. There is a hostel for students in connection with the College.

* *Royal Institute of Science.*—Next to the Elphinstone College, is the large building which contains this Institute with its physics, chemistry, botany and zoology laboratories. It also possesses a good scientific library. The Institute began work in 1920 (see page 61).

Wilson College.—In 1832, the Rev. Dr. John Wilson, of the Scottish Missionary Society, collected a public subscription and opened a small English school in the Military Square in the Fort. It was recognised officially by the Church of Scotland in 1835 as the "General Assembly's Institution" which under the reverend doctors' able teaching attained the status of a College even in those pre-university days. With the Disruption, how-

ever, the school passed on to the Established Church. Dr. Wilson who had adhered to the Free Church, then built in Girgaum, the Free General Assembly's Institution, accommodating both a school and a college of which the College was recognised by the University in 1861. The present Wilson College which is situated at Chowpatty was opened by Lord Reay in 1889. Attached to it are residential quarters and hostels for students.

St. Xavier's College.—This was originally founded in 1868 for the purpose of educating students of the Roman Catholic faith, and from the beginning consisted of a High School and a College; the College was recognised by the University in 1869. It admitted students of other denominations from the very onset and from 1878 to 1890 was located in a large building on the Esplanade Cross Road. The present St. Xavier's Collège is situated on Cruickshank Road and contains several lecture rooms, physical, chemical and biological laboratories and also residential quarters for the professors who are chiefly members of the Society of Jesus. There is also a Students' Hostel in connection with it.

The Sydenham College of Commerce and Economics—"The general purpose of this college is to furnish young men embarking on a business career with a university education of such a kind as will assist them by deepening and widening their understanding of industrial and commercial organisation, to rise to the more important and responsible positions in their respective vocations and concurrently from the larger public and cultural point of view to promote the study of social conditions in general by means of specialised courses in the various branches of Economic Science and by original research."

* The College which is a Government Institution was opened in October 1913. It is affiliated to the University of Bombay, and alone of all institutions in India provides a systematic course of study leading upto the degree of Master of Commerce. There are about 12 Government special scholarships sanctioned for 'Intermediate' and 'Backward' Hindus and Mahamedans. There are as well University, College and State scholarships, in addition to prizes and a gold medal. It has got its own hostel in a rented building. Apart from the degree course, classes for preparing students for Government Diploma in Accountancy Examination are held in the College generally in the evening. Shorthand classes are also held. Short courses of evening lectures on some important commercial and economic problems are delivered free of charge for the benefit of those engaged in business during the day and desirous of studying in their spare time some particular subject in which they happen to be interested. The first principal was Mr. P. Anstey and Mr. M. L. Tannan is principal at present.

M. L. TANNAN.

Government Law College.—This was founded in honour of Sir Thomas Erskine Perry, Chief Justice of Bombay, on the eve of his departure in 1852. It was recognised by the University in 1860. The College possesses an excellent Library.

Grant Medical College.—This is the only Institution in the Bombay Presidency for teaching medicine which is recognised by the University of Bombay. It is situated in the grounds of the Jamsetji Jijibhoy Hospital on Parel Road and was founded in 1845 in memory of Sir Robert Grant, Governor of Bombay. The building was designed by Capt. W. B. Goodfellow, R.E., and is in keeping with the style or architecture of the J. J. Hospital which adjoins it. It is provided with probably the highest porch in Bombay adorned with the Coat-of-Arms of Governor Grant and the East India Company. With the exception of certain endowments for the encouragement of deserving students the college is entirely supported by Government. It was recognised by the University in 1860 and is well equipped with Laboratories for practical work in all branches of medical science. A large Anatomy building with dissecting rooms has lately been added and Laboratories for practical work in Physiology, Public Health and Pathology have recently been built and equipped in a thoroughly up-to-date manner. Attached to the College is a large hostel.

Adjoining the Grant Medical College is the Framji Dinshaw Petit Laboratory for Scientific Medical Research.

* KING EDWARD VII MEMORIAL HOSPITAL

AND

* SETH GORDHANDAS SUNDERDAS MEDICAL
COLLEGE, BOMBAY.

HISTORY OF THE HOSPITAL.

By the passing of the Bombay Police Charges Act in 1907 it became imperative on the Municipal Corporation of the City of Bombay to extend the work of Medical Relief in the city. The want of a fully equipped large general hospital was keenly felt to meet the growing demands of the rapidly developing portions of the North of the Island. In the year 1909 the Municipal Commissioner was asked by the Committee, appointed by the Corporation for the purpose of extending Medical Relief, to put before them definite proposals for the establishment of a fully equipped modern hospital in a suitable locality. Soon after

this on the death of His Imperial Majesty, King Edward VII, the people of Bombay decided to raise a suitable Memorial to His reign in the City. In September 1911 the Secretaries of the Memorial Fund Committee informed the Corporation that their Committee had decided that "a hospital in the Northern part of the Island would form a most fitting Memorial to His late Majesty." They also informed that they had collected funds to the extent of about six lakhs of rupees and that the Government had granted a free site measuring 50,000 square yards on the Parel Government House Estate ; the market value of which was then estimated at five lakhs of rupees. The Corporation welcomed this offer of assistance and replied that, as they had intended to build a hospital themselves, they would be prepared to build, equip and maintain the hospital. Towards the cost of its construction the Government subsequently contributed a sum of four lakhs of rupees. The foundation stone of the Hospital was laid on the 25th December 1920, and the building is now ready for occupation.

The Design.—The hospital, which will accommodate 304 beds, is designed on the modern pavilion system. A straight corridor runs from North to South with the various buildings branching off at right angles. The hospital proper or the main blocks connected to the corridor are as follows :—In the centre is the admission and administration block with the kitchen and stores behind and the quarters for the Resident Doctors and an Operation Theatre on its first floor. On the South side are the two Ward pavilions for medical cases. On the North are the two Ward pavilions for surgical cases. Each pavilion contains 52 beds. The Out-Patients' block is on the North. The Maternity Hospital with a separate entrance of its own and the Ophthalmic Hospital are on the East ; so also the Casualty Ward and the Main Operation Theatre. At the South-West corner of the site is the Nurses' Home, a three-storeyed building and connected with the hospital by covered way. It provides accommodation for 50 Nurses. On the Eastern boundary of the site are located the Pathological Department and Mortuaries connected with the main building by a covered way. An Isolation Ward is also provided. Besides these main buildings there are Steward and Engineer's bungalow, quarters for Compounders and Servants and a laundry. The hospital has a Casualty Department which will be open day and night. The large Out-Patients' block with separate entrances for men and women contains Departments for up-to-date treatment and diagnosis of ear, nose and throat, dental and skin diseases, besides the usual medical, surgical and gynaecological departments. Ante-Natal Clinic and a large X-Ray and Electro-therapeutic Departments are also provided for.

THE COLLEGE.

In the year 1916 another development took place in the history of the Hospital. At the instance of the Trustees of Seth Gordhandas Sunderdas, the then Advocate-General, the Hon. Mr. D. N. Bahadurji offered to the Corporation Government Loan Notes of the face value of Rs. 12 lakhs (which was subsequently increased to Rs. 14,50,000 in 3½ per cent. Government Promissory Notes) for endowing a Medical College in connection with the King Edward VII Memorial Hospital. The endowment was made on the following conditions :—

- (a) That the College should be established in connection with and be attached to the King Edward VII Memorial Hospital.
- (b) That the College should be affiliated to the University of Bombay and proper provision should be made therein for giving instructions to the highest medical degree of the University.
- (c) That the Corporation should provide the necessary buildings and equip the College with all necessaries for giving proper instructions.
- (d) That the Corporation should ever afterwards maintain the College and defray the necessary recurring expenditure for the purpose.
- (e) That the Professors and Teachers to be employed at the College should all be properly qualified independent Indian Gentlemen not in Government Service.
- (f) That the College should be named the "Seth Gordhandas Sunderdas Medical College."

Seeing that the need for another Medical College in the Presidency was keenly felt the Corporation accepted the munificent offer. A Sub-committee was formed consisting of some of their Members, the Municipal Commissioner and the representatives of the Bombay Medical Union, who were very much interested in the establishment of another Medical College in Bombay.

The College is a handsome three-storeyed building designed in E shape with the possibility of future extension by the erection of another three-storey wing to the North-East providing for an increase of 60 per cent. on the present accommodation. The College has a Students' Hostel attached to it with an accommodation for about 100 students.

The College has been affiliated provisionally to the University of Bombay in the Faculty of Medicine and for the course of

study prescribed for the Intermediate-M.B., B.S. Examination for a period of 18 months for the present. The second inspection by the University will be held in January 1926.

The Cost.—The Hospital and the College buildings have cost in construction considerably more than the original estimates owing to the prices of everything going up after the War. The Hospital will cost over 42 lakhs of rupees, including the value of the free site, and the College about 18 lakhs to construct. In spite of this heavy expenditure, the Municipal Corporation of Bombay have not stinted in equipping both the College and the Hospital with the latest appliances, instruments, apparatus, books, etc., in all their departments. The cost of equipping the Hospital and the College will come to over eight and five lakhs of rupees, respectively. The annual recurring expenditure to the Bombay Municipality for the maintenance of the Hospital and the College will come to over six lakhs a year.

The Staff.—The administration of the College and the Hospital will be in charge of the Dean, who will be responsible to the Corporation for their efficient management. Besides the usual teaching staff obtaining in all modern Medical Colleges, the different departments of the College will be directed by four full-time Professors. Moreover the Bombay Municipal Corporation have been very fortunate in securing the services of 23 highly qualified Indian Doctors to serve the Hospital and the College in an honorary capacity.

JIVARAJ N. MEHTA.

* SECONDARY TRAINING COLLEGE, BOMBAY.

The Secondary Training College exists to provide secondary schools with a supply of trained teachers and to undertake investigations into educational problems. It was founded in 1906 and for the first fourteen years of its existence prepared teachers for its own diploma which was known as the Secondary Training College Diploma (S.T.C.D.). In 1920 the College was affiliated to the University of Bombay for the purposes of the degree of Bachelor of Teaching. The curriculum of the College is now based on the requirements of the University for that degree. The diploma S.T.C.D. is no longer given by the College.

The College is located in Cruickshank Road, Bombay, in the Elphinstone High School Buildings. It uses that school as its Practising School.

Admissions.—The College is open to all graduates of the University of Bombay or of a University recognised by the University of Bombay in any Faculty. The College will accommodate a maximum of 50 teachers a year, a few places are reserved

for Government teachers; the remaining places (30 or more) are open to graduates desirous of qualifying for the B.T. degree. Preference is given to teachers deputed from recognised schools in this Presidency. The College is open to students of either sex.

Fees and Scholarships.—No fees are charged for tuition. Scholarships of Rs. 50 per mensem, not exceeding ten in number are awarded annually by the Director of Public Instruction to selected teachers from non-Government schools and to graduate students not attached to any particular school. Teachers deputed to the College by the Director of Public Instruction from Government Schools receive their ordinary pay plus any allowances sanctioned for them.

Hostel.—The College hostel situated near the College accommodates 22 students. All full-time students are eligible for rooms but preference is given to Government teachers. One of the senior members of the College staff is resident Superintendent of the hostel and the Principal resides in the same compound.

Staff and Curriculum.—The staff consists of a Principal and five other masters of Method, each of whom is a specialist in the art of teaching his own subject. The curriculum is made to suit the requirements of the B.T. degree but the College lectures and demonstrations aim at giving the student a broad view of his subject without seeking to expound any particular text-books. The lectures include the following subjects:—

The Principles of Education (Philosophical, Psychological, Ethical and Social); The History of Education (European and Indian) and the Practice of Education (School management and Hygiene, Modern movements in Education, and special methods). The practical work of the College is conducted along experimental lines.

H. R. HAMLEY.

* UNIVERSITY SCHOOL OF ECONOMICS AND SOCIOLOGY.

THIS institution is one of the most important additions to the intellectual life of Bombay that have been made since the Congress last met in this city. The establishment of this school is very significant in the history of University education in this Province, as it represents the first organised attempt of the Bombay University at imparting instruction and training in research-methods under its own professors. When the Department of Sociology was started in 1919, it seems, Bombay was the only one among Indian Universities to employ a full-time professor to conduct sociological studies and thus to give practical recognition to the value of the study of this subject. At

present the Sociological Department is manned by two readers, while the Economics branch is conducted by one professor and one assistant professor. These teachers deliver lectures so as to cover the syllabus in Economics, and Sociology that is prescribed by this University for the degree of M.A. They take particular interest in training students who intend to proceed for the M.A. by means of a thesis. There is a fairly large collection of books on Economics and Sociology, which, it is hoped, will be shortly enriched by the addition of some rare books and periodicals. The preparation of a bibliographical card catalogue is also contemplated, which when completed will greatly enhance the value of the Library of the School. The wholesome result of these facilities is to be seen in the valuable research that is being steadily turned out from this School both by the staff as well as by the students. There are altogether 56 students on the register, of whom 15 are working at their theses. The School is housed in a magnificent building specially erected for it and forms the South Wing of the University Buildings. It is run at an annual cost of Rs. 40,000 and upwards.

In 1912 the Government of India made a liberal offer of a non-recurring and a recurring grant to the University with a view to enable it to develop its teaching side. The Committee appointed by the Syndicate to submit a scheme of development, proposed among other things, the appointment of a full-time professor of Economics. But somehow the question was being postponed, when in 1914 the Government of India made a concrete proposal for the endowment of a School of Economics and Sociology. The Syndicate forthwith prepared a plan and in 1919 appointed the first professor of Sociology followed, in 1921, by the professor of Economics. Immediately thereafter one assistant professor was attached to each of the two. In 1924 the Department of Sociology was remodelled and only one Reader was put in charge of Sociology, another being added in 1925.

G. S. GHURYE.

* THE FIRST BOMBAY BATTALION, UNIVERSITY TRAINING CORPS.

THE Bombay University Training Corps, having for its aim the training of students of the Bombay University in military matters, is constituted under the Indian Territorial Force Act, 1920. It owes its origin to the Indian Defence Force, a corps raised in 1917 for local defence, one company of that force being raised in Bombay and another in Poona from among students of the University. The present authorised strength of the Battalion

is 670 of all ranks, which strength has been fully maintained since the unit was raised. The organisation is on the four company basis, one company being stationed in Bombay, two in Poona, and one divided between Dharwar and Sangli. Platoons, four to the company, are raised on a college basis, the Bombay Company consisting of an Elphinstone College, a Wilson College, a Grant Medical College, and a St. Xavier's College Platoon.

The Head-Quarters were originally in Bombay but on account of lack of suitable accommodation were transferred to Poona in 1923. Training is carried on from June to December by parades held at least weekly and in December all detachments are concentrated for an annual camp of exercise lasting for fifteen days and usually held near Poona. More than 600 of all ranks attended the last camp held at Pashan in December 1924 and January 1925.

In all over 1,800 students have received or are receiving some measure of military training in the corps since its formation. A considerable expansion in numbers has been recommended by the Shea Committee.

The Director of Public Instruction in his report of 1922-23 quotes and endorses the following report of the Commandant of the Corps: "This movement, I think, is a most valuable factor in student life. It inculcates habits of self-respect, discipline and camaraderie, and affords to those students and those of the staff who go to Camp an opportunity of getting to know one another in a way that would otherwise be impossible."

A. L. COVERNTON.

* THE BOMBAY STUDENTS' BROTHERHOOD.

THE Bombay Students' Brotherhood is one of the pioneer associations of the city, helping the growth of corporate feeling and of the habits of serious thought and mutual service among High School and College students. It started in 1889 as a small Sunday Class for moral instruction under the inspiring guidance of Mr. N. G. Welinkar, now in the educational service of H. E. H. the Nizam. The idea caught on and in a few years' time other activities grew round this nucleus, the need for organization was felt and the Students' Brotherhood came to be formed with definite aims and objects. The Sunday Class for the serious study of some thought-provoking book has continued to be held regularly all through the last thirty-five years and more, and men like the late Sir Narayan Chandavarkar have been teachers thereof. Besides that, the Brotherhood conducts a

reading-room and library, arranges lectures by men distinguished in literary or public life, organizes debates among its own members and with sister institutions, holds elocution competitions and social gatherings and thus tries in various ways to create a feeling of brotherhood, irrespective of creed or caste and to provide a common platform for young men belonging to various educational institutions of this cosmopolitan city.

The Brotherhood has a membership of 558, and its present president is Mr. M. R. Jayakar. The office and head-quarters are at the Arya Bhavan, Sandhurst Road, Girgaum, Bombay 4.

R. M. JOSHI.

* THE SOCIAL SERVICE LEAGUE.

THE League is now in the fourteenth year of its existence, having been established on the 19th March 1911.

The present activities of the League may be briefly classified as follows :—(i) Promotion of mass education by means of night-schools, libraries and magic lantern lectures. (ii) Organization of Boy Scout Corps and Boys' Clubs. (iii) Promotion of public health by supervision of medical relief through (a) free dispensaries, (b) sanitation work in the city, (c) sanitation work in rural tracts by administering the Florence Nightingale Village Sanitation Fund, and (d) child-welfare propaganda. (iv) Work for women, e.g., reading-rooms, home-nursing and first-aid classes, etc. (v) Co-operating with the Bombay Presidency Released Prisoners' Aid Society by guiding and supervising the work of their Police Court Agent. (vi) Prison preaching, (vii) Spreading the co-operative movement among the working classes. (viii) Securing compensation for workmen for accidents. (ix) Organizing recreation for the working classes in the form of fresh air excursions, out-door sports, Indian gymnastics, amateur theatrical performances, etc. (x) Social work at the Parel Settlement. (xi) Social work at the Madanpura Settlement. (xii) Activities carried on by the Bombay Working Mens' Institute, Parel. (xiii) Propaganda work through the medium of the Social League Quarterly (English), the Samaj Sevak (Marathi), lectures on social subjects, Social Service Library, training class for social workers and registration of social service institutions.

The League has a membership of 1,008 and its work is carried out principally by its five life-workers. Mr. N. M. Joshi of the Servants of India Society is the General Secretary of the League. Its office and library are in the Servants of India Society's Home, Sandhurst Road, Girgaum, Bombay 4.

R. M. JOSHI.

* THE BOMBAY YOUNG MEN'S CHRISTIAN ASSOCIATION

was founded in 1874 in rented rooms in Kalbadevi with a foundation membership of 150, chiefly Europeans. The Association has now four well equipped buildings (a) in Wodehouse Road, Fort, serving principally young Europeans, (b) in Lamington Road, Girgaum, entirely devoted to work among Indian Students, (c) in Rebsch Street, Byculla, devoted to the service of Anglo-Indian apprentices and other youths and (d) at Reynolds Road, Byculla, providing a centre for young Indian business and professional men and senior students. The buildings provide Hostel accommodation for 200 young men and have a membership of 1,000. A regular programme of Educational, Social, Physical and Religious work is carried on in each Centre, including Lectures by prominent educationists, Classes, Debates, Study Circles, Gymnasias, Sports and Athletics, Concerts, Social and Religious meetings, etc.

The Association has recently organised a demonstration centre in Social Welfare service for industrial workers and their families, living in the new Development Directorate Chawls at Naigaum, which includes evening classes, organised mass games, First Aid, Lantern Lectures on health and other subjects and special activities for women and girls. This centre provides a clinic for social service training for students and other members of the various Y. M. C. A. branches.

Another development during the present year has been the organisation of a City Physical Department which in addition to promoting a physical programme in each of the Y. M. C. A. Branches is conducting two demonstration Playgrounds thoroughly equipped and supervised in congested areas, at the special request of the City Corporation. It is co-operating with the Education Authorities in the promotion of scientific physical education in the Schools of the Presidency and the training in Physical work of picked teachers from the High Schools. It is also co-operating with the University in promoting a Physical Education programme in the various Colleges.

MEDICAL INSTITUTIONS.

St. George's Hospital.—The first hospital for "Sick English" in Bombay was established in 1677 by Gerald Aungier on the Esplanade near the Cooperage, but was transferred to a building opposite the Great Western Hotel building in 1733, and was the General Hospital for Europeans in both military and civil employ. In 1824 the hospital was transferred to Hornby Road, where as a number of thatched buildings it occupied a site near the Sir

Jamsetji Jijibhoy Parsi Benevolent School, and continued to be in use until 1860 when it was condemned by the medical authorities. It was thereafter temporarily located in the European Artillery Barracks in Fort George. The foundation stone of the present hospital—named St. George's Hospital—which is to the east of the Victoria Terminus Station was laid by Lord Reay in 1889. It has general and special wards and is equipped in an up-to-date manner. The Convalescent Home in connection with this hospital is situated on the Hill-Station Khandalla.

The St. George's Hospital Nursing Association provides a large staff of nurses for the hospital and also for private out-door work.

Sir Jamsetji Jijibhoy Hospital.—This Hospital was built in 1845 at the joint expense of Sir Jamsetji Jijibhoy, the first baronet, and the East India Company, and is situated near the junction of Parel and Babula Tank roads. It was designed to afford medical relief to the poor Indian population of all classes. There is accommodation for nearly 300 beds, with detached buildings for Parsi male patients and for chronic cases. A fine operation block has been added to the hospital and is known as the "Moore Operation Theatre."

Cowasji Jehangir Ophthalmic Hospital.—Adjoins the J. J. Hospital and was originally built in 1866, but has lately been considerably enlarged.

Bai Motlabai Obstetric Hospital and Petit Hospital for Women and Children are situated to the east of the J. J. Hospital and attached to them is the Dwarkadas Lulloobhoy Dispensary. These institutions were opened in 1892.

The J. J. Hospital and the adjoining special hospitals mentioned above form the principal centre for clinical instruction in connection with the Grant Medical College; they are all exceedingly well equipped for the purpose of imparting practical knowledge to the medical students. A Nursing Association under the charge of the Sisters of All Saints provides an excellent nursing staff for these hospitals, and also for private cases outside.

King Edward VII Memorial Hospital was opened up as a "Hospital in the Northern part of the Island" and as "the most fitting memorial to His late Majesty." This excellently equipped hospital, in almost all branches, is attached to the Seth Gordhandas Sunderdas Medical College, which started its activities only recently (pp.37-40).

The Gokuldas Tejpal Hospital is situated on the Esplanade Cross Road, and the *Cama and Allbless Hospitals*, which are for female patients only, on Cruickshank Road.

Of the *Military Hospitals* the *Station Hospital* for European troops and officers is situated at Colaba, while the *Marine Lines Hospital* is for Indian troops.

Of the Municipal Infectious Diseases Hospitals, the *Maratha Plague Hospital* is situated in Connaught Road to the north of the Victoria Gardens, and is reserved for the treatment of plague cases only, while the *Arthur Road Hospital* which is located near Jacob's Circle is meant for the treatment of other infectious diseases.

Acworth Leper Asylum.—This asylum is located at Matunga about $1\frac{1}{2}$ miles to the north of the Bombay Bacteriological Laboratory. A large *Adansonia* tree, nearly 40 feet in circumference and said to be hundreds of years old, stands where the private road to the Asylum branches off Wadala road. The institution was opened in 1891 and is situated in a neat little garden and accommodates about 350 lepers. The inmates are located in wards most of which are old and stand upon the foundations of Artillery barracks which in olden times had to be abandoned on account of the prevalence of guineaworm disease among the artillery men. The old wards however are being gradually replaced by more up-to-date ones. In the compound are Protestant and Roman Catholic churches, a Hindu temple and a Muhammadan Mosque for religious observances on the part of the inmates.

Attached to the Asylum is a successful sewage farm. All sewage from the Asylum buildings is conveyed by means of a water carriage system to a "Septic" tank where it settles the solids undergoing disintegration while the supernatant fluid which is full of nitrites and nitrates passes on as effluent which is utilized on land for growing crops of Maize and Jowar which are sold as fodder for animals. The marsh gas given off during the process of disintegration of the sewage was at one time utilised for working a small gas engine, cooking and for lighting the compound. This installation, however, has now been done away with. A small engine worked with oil, pumps the effluent up into a storage tank from which it is distributed by means of channels all over the farm. The effluent, if purified still further by passing it through filters, of which there are various patterns, comes out as a clear, odourless, and sparkling fluid.

Bombay Sanitary Association.—This association was founded in 1904 to (1) create an educated public opinion with regard to sanitary matters in general; (2) to diffuse the knowledge of sanitation and hygiene generally and of the prevention of the spread of disease amongst all classes of people by means of lectures, leaflets and practical demonstrations, and if possible, by holding classes and examinations; (3) to promote sanitary science by giving prizes, rewards or medals to those who may by diligent application add to our knowledge in Sanitary Science by original research or otherwise; (4) to arrange for

homely talks or simple practical lectures for mothers and girls in various localities and different chawls.

The association has now a building of its own—The Sanitary Institute—at Princess Street, provided with a Lecture Room, a Class Room and a Museum of Sanitary Appliances. Popular lectures and practical demonstrations are given from time to time by distinguished persons on subjects connected with Sanitation, Hygiene and various diseases.

Under the auspices of Lady Willingdon a scheme had been inaugurated for securing proper treatment for poor women during confinement and proper care of their infants at birth. Three hospitals have already been opened for the purpose and have been doing excellent work.

King George V Anti-Tuberculosis League.—This League was organised in 1913 to establish special measures for the prevention of Tuberculosis in its varied manifestations, and with this view has devised the following plan of campaign as the best suited to local conditions and requirements :—(1) Notification of disease ; (2) Tuberculosis Dispensaries ; (3) Education of the People ; (4) Medical Inspection of School children ; (5) Supervision of milk and food supplies ; (6) Special fund to relieve distress, and (7) to arouse public interest in Tuberculosis.

The League is located in the Sanitary Institute in Princess Street where it has its Information Bureau and Museum. There are two special Tuberculosis Officers attached to it, with two Tuberculosis Dispensaries under their charge. The League opened a Sanatorium at Parel in 1918.

The League for combating Venereal Diseases.—This was founded under the auspices of the Bombay Sanitary Association in 1917 with the following aims and objects :—(1) to disseminate knowledge for the prevention and cure of venereal diseases and to provide accurate and enlightened information as to their prevalence ; (2) to promote the provision of greater facilities for their modern treatment ; (3) to increase the opportunities of medical students and practitioners for the study of these diseases ; (4) to encourage and assist the dissemination of a sound knowledge of the physiological laws of life in order to raise the standard both of health and conduct ; (5) to co-operate with existing associations to seek their approval and support and to give advice when desired ; (6) to arrange for courses of lectures, etc., and to publish suitable literature ; and (7) to promote such legislative, social and administrative reforms as are relevant to the foregoing aims and objects.

The League has an Information Bureau and Dispensary at 66, Lamington Road, well equipped with all the necessaries for

free diagnosis and treatment of venereal diseases with a staff of Medical Officer and a Lady Physician.

MUSEUMS.

The Royal Asiatic Society's Museum is located in the Town Hall and was opened in 1816 for the collection and preservation of Antiquities and Specimens of the Natural History, Arts, and Mythology of the East. It contains a priceless collection of archæological relics, and carvings, inscriptions and copper plate of great interest. Notable among the collection is a stone coffer found at Sopara in Salsette, containing relics of Buddha ; it is seen at the west end of the main Reading Room of the Society's Library. The Library possesses a large collection of invaluable Oriental Manuscripts, and the museum also contains the Charts and Survey Maps which once belonged to the Bombay Geographical Society which was amalgamated with the Royal Asiatic Society in 1873. A number of specimens of geological and geographical interest, presented by the Bombay Anthropological Society in 1896, are now located in the Prince of Wales Museum. The museum also owns a number of ancient gold, silver and copper coins found in various parts of India.

The Victoria and Albert Museum is located in the Victoria Gardens at Byculla and was founded in 1858. The collection was originally commenced in 1848 and was at first lodged in the Mess Rooms of the old Town Barracks. But in 1857 on the outbreak of the Mutiny, the military authorities urgently required these rooms, and during the work of removal the specimens were either damaged, destroyed, or lost. The remnants were next lodged in the Town Hall where they remained uncared for until finally removed to the present building in 1872. The Victoria and Albert Museum is built in the Italian Renaissance style ; the interior is highly ornamental, but the fine ceiling has been spoilt by letting into it two unsightly sky lights. The collection consists of all kinds of indigenous economic products and a few natural history specimens. The "Old Bombay" rooms contain an interesting collection of prints, drawings, maps and photos of old Bombay of which a catalogue can be obtained in the Museum.

The Natural History Museum was originally founded by the Bombay Natural History Society in 1883. The Museum contains a large collection of birds, snakes, lizards, small animals, insects, marine and land shells, fishes, birds' eggs and a herbarium. It also owns a fine collection of heads and skulls of Indian Mammals and a collection of geological specimens.

These collections are now housed in the Prince of Wales' Museum.

The Museums of the Sanitary Association and of the Anti-Tuberculosis League are located in the building of the Sanitary Institute in Princess Street and contain models, charts and drawings in connection with Sanitation and Public Health, and photographs, specimens, appliances and models for the education of the public in the matter of prevention of Tuberculosis.

* PRINCE OF WALES' MUSEUM OF WESTERN INDIA.

Building.—Fronting the Sailors' Home, the Royal Institute of Science and the Elphinstone College, and butting on Rampart Row to the north, stands the magnificent domed building in Indo-Saracenic style, called the Prince of Wales' Museum of Western India. This building is a permanent memorial of the visit in 1905 of their Royal Highnesses the Prince (now H. M. King George V) and Princess (now H. M. Queen Mary) of Wales'. Though the question of providing Bombay with a Museum had been discussed in earlier years, the history of the Prince of Wales' Museum may be said to begin with the appointment by Government in 1904 of a committee to investigate the subject.

Donations.—In connection with the Royal visit and in furtherance of the desire of the public for a Museum, several liberal contributions were received from the distinguished citizens and institutions of Bombay Presidency: The then Mr. Currimbhoy Ibrahim made a gift of Rs. 3,00,000, Government granted Rs. 3,00,000, His Highness the Nawab of Junagadh donated Rs. 12,000 and Sir Cowasji Jehangir gave Rs. 50,000, the Corporation contributed Rs. 3,58,000 in Government Securities; and Government and the Corporation have also been making further grants subsequently.

Design of the Building.—The present block was designed and built by Mr. Wittet (then Consulting Architect to Government). This building is one of the three blocks which made up the original design and was completed in 1914.

Management.—The management and maintenance of the Museum has been entrusted to a Board of Trustees under the Prince of Wales' Museum Act III of 1909. The Museum is maintained from annual grants made by Government and the Corporation.

Opening of the Museum.—The building during the War was used as a Military Hospital and came into the possession of the

Trustees for Museum purposes only in 1920. After the collections had been assembled and show-cases made, the opening ceremony was performed by Her Excellency the Honourable Lady Lloyd on January 10th, 1922, when the three main sections, namely, Art, Archæological and Natural History, were thrown open to the public.

Growth of Sections.—These Sections have continued to grow and flourish since the opening date, and to-day they are visited by many learned and distinguished persons, by students, and others, to whom they furnish a wide field of instruction and interest, while the staff of the Sections are engaged in the process of mounting specimens, arranging, classifying, labelling and cataloguing exhibits.

Art Section.—The most attractive Department of the Museum is the Art Section containing the valuable collection of a pleasing variety of pictures and 'objects d' Art' such as ceramic, jade, brass, crystal, silver, arms, drapery, etc., bequeathed by the late Sir Ratan Tata, a collection of pictures, statuary, etc., presented by Sir Dorab Tata, and a collection of Mughal pictures and Maratha relics obtained by purchase. The fact that the Sir Ratan Tata Collections were made available to the public so soon is due to the generosity and public spirit of Lady Ratan Tata, whose benefactions to the Museum have been numerous and munificent and who continues to maintain her keen interest in the Museum.

Archæological Section.—The Archæological Section comprises of a Brahmanical Gallery, a Jain, Pre-historic and Foreign Antiquities Gallery, a Buddhist Gallery and an Epigraphical Section. It includes the loan collection of the Bombay Branch Royal Asiatic Society, specimens lent by the Director-General of Archæology and a few specimens received as gifts. There is also a large and interesting collection of coins.

Natural History Section.—The Natural History Section consists of the Bombay Natural History Society's valuable and interesting collections of Mammals, Birds, Reptiles, Amphibians, Fish and Invertebrates. The exhibits on view in the Section do credit to the Taxidermy Department.

Forest Specimens.—There are also a few specimens illustrating the forest resources of Bombay Presidency and their commercial possibilities.

Minerals.—Mr. J. Ribeiro's collection of the minerals of Bombay Island is also on view.

Garden and grounds.—The garden and grounds are a source of pleasure to the public and take their modest share in forming a lung of the city, in that they form a suitable place with

their flower-beds, lawns, sand-pit, shrubbery and fernery, for the recreation and enjoyment of children and adults.

Appeal for funds.—The Museum also requires additional space and funds for the furtherance of its activities and growth. The limited accommodation in the existing building and the inadequate funds at the disposal of the Board have proved to be the main hindrances to the expansion of each of the Sections. The Board, however, trust that as the importance of having a fully developed Museum comes to be realised by the public, more public funds, donations, and bequests by the wealthy, such as are commonly made to similar institutions in Europe and America, will be forthcoming, so that additional accommodation can be provided and equipped and funds for the increasing expenses provided.

“The Museum is ordinarily open to the public on all the days of the week except Monday, from 10 a.m. to 5-30 or 6 p.m. (S.T.). Admission is Free except on Wednesday when a small fee for admission is charged. On Monday the Museum is entirely, closed to visitors.”

J. F. JACOBS.

PLACES OF WORSHIP.

PROTESTANT CHURCHES.

St. Thomas' Cathedral.—The work of building this church was started in 1676 with a fund of Rs. 50,000 chiefly contributed by the Company's servants who “came forward freely and conscientiously offering one year's wages, some half a year's and the least a quarter.” After the walls of the building had risen to a height of 15 feet, it was discovered that the funds had mysteriously disappeared and it was noised that some one in high authority had misappropriated them for his own use. And then, for a period of nearly 40 years, the bare walls remained a prowling place for “dogs, bandicoots and badmashes of all sorts” during the day and jackals at night. This scandalous state of affairs was removed by the arrival of the Rey. Richard Cobb, Chaplain to the East India Company, who in 1715 made a stirring appeal “to wipe away the reproach of being godless in the sight of the heathen” and to complete the ruinous edifice. The result was that fresh subscriptions were collected, the foundation stone of a new edifice was laid and on Christmas Day 1718 Governor Charles Boone opened it in state naming it St. James' Church. In 1816 it was consecrated by Dr. Middleton, the first Anglican Bishop in India, in the name of St. Thomas the Apostle,

In 1833 Bombay was raised to the dignity of a Bishopric and its first Bishop Dr. Carr was installed in 1838. The Church thenceforth became St. Thomas' Cathedral, and to commemorate the event the old belfry was replaced by the present tower and the clock.

The Cathedral contains a number of fine monuments of historical interest. The three upper clerestory windows were erected to the memory of Michael Scott, a merchant, and the five lancet windows to the officers of the Royal Engineers. The muniment chest contains a silver chalice presented by Aungier to the Christian community of Bombay in 1673.

The Christ Church at Byculla is the second oldest church on the Island ; it was opened in 1833 and consecrated in 1835.

The Church of St. John the Evangelist, better known as the *Afghan Memorial Church*, is at Colaba and was built in 1857 in memory of the officers, non-commissioned officers, and private soldiers who died in the campaign of Sind and Afghanistan in 1838-43.

All Saints Church which is prettily situated in a little open garden near the Malabar Hill Reservoir was consecrated in 1882.

St. Andrew's Church stands near the Great Western Hotel building, and was opened in 1819, while the *United Free Church of Scotland* is in Waudby Road.

ROMAN CATHOLIC CHURCHES.

When Bombay was ceded by the Portuguese the chief Roman Catholic Churches on the Islands were those of *N. S. de Esperanca* on the Esplanade, *N. S. Senhora de Gloria* at Mazagon, *N. S. de Salvacao* at Dadar, *San Miguel* at Upper Mahim, and also a church at Parel on the site of the old Government House, but the name of whose patron saint is not known. Of these the *N. S. de Esperanca* had to be removed from its original site on the Esplanade in 1760 on account of its coming in the way of the guns from the fort ramparts, and in its place the present church in Kalbadevi was erected at the expense of the Government. The Church at Parel, after serving as the Old Government House, is the Bombay Bacteriological Laboratory, now known as Haffkine Institute. The Church of *N. S. de Gloria* has lately been removed from Mazagon and erected at Byculla. Of the new churches that of the Holy Name built in 1905 is in Wodehouse Road, while *St. Ignatius' Church* is at Jacob's Circle.

FIRE TEMPLES.

Fire is the chief object of veneration among the Parsis, and the Fire Temple is their public place of worship. The chief

Fire Temples are known as Atash Behrams in which is worshipped the fire of Behram composed of 16 kinds of fire. There are four Atash Behrams in Bombay. The fire kept in a Fire Temple called the Agiari is known as the Atash Adran.

The oldest chief Fire Temple in Bombay is the Dadysett's Atash Behram in Girgaum, which was consecrated in 1783 according to Kadmi rites; while Wadia's Atash Behram at Princess Street was consecrated according to Shehenshahi rites in 1830. The first Agiary founded was the Fort Agiary in 1730; the second Agiary was also built in the same district and dates from 1733.

MOSQUES.

The Muhammadan community of Bombay possesses a number of mosques of which the most noteworthy are:—The Juma Masjid in Sheikh Memon Street; the Jackeria Masjid in Mandvi; Ismail Habib Masjid near Memonwada, and the Mogul Masjid near the Jail Road; the Bohra Masjid is near the Juma Masjid and there is a masjid near the tomb of Makhtum Shah at Mahim.

The Juma Masjid.—The original Juma Mosque of Bombay was built by Konkani Muhammadans but the date is not known. It was situated near the old "Dongari" Fort but was removed during the administration of Mr. Bouchier (1750-60) and erected on the Esplanade in front of the shrine of Pedro Shah near the Victoria Terminus Station. In 1771 this mosque also had to be dismantled by the order of Governor Hornby which forbade the existence of any building within 600 yards of the walls of the Fort. The present Juma Masjid is situated in Sheikh Memon Street, and has been in use since 1802; it is built over an ancient tank.

The Mahim Shrine.—This shrine and mosque were erected in honour of a Muhammadan Pir or Saint named Makhtum Fakih Ali Paru who died at Mahim in 1431. The saint was of Arab origin and had acquired a great reputation for piety and learning during his life-time. Close by is a very ancient step well probably belonging to the time of Raja Bimb. A great fair is held annually at Mahim in honour of this Pir.

TEMPLES.

Mumbadevi Temple.—The original Mumbadevi temple from which Bombay derives her name stood near the Victoria Terminus, and was a shrine of the aboriginal fishermen who inhabited these islands. This temple had to be demolished in 1737 for enlarging the fortifications, and a new temple was erected under the orders of Government on the present site at Mumbadevi. This temple enclosure now contains a number of other shrines and a large tank which has been built subsequently.

Walkeshwar Temple.—The original Walkeshwar temple was built at the extreme point of Malabar Hill by the Silhar rulers of the Northern Konkan probably in the eleventh century, and it was this temple and the Shrigundi or the Holy Rock which stood in the sea close by, which first made Bombay famous as a place of pilgrimage among the people of Malabar—hence the name Malabar Hill. This original Walkeshwar temple was destroyed either by the Muhammadans or the Portuguese but a temple built in 1060 by the same rulers at Ambarnath near Kalyan exists to this day. The present Walkeshwar Temple is situated near the Walkeshwar Village and was built in 1715; in front of it is a sacred tank called Bānagangā which is an important place of pilgrimage in Western India. The name is derived from *Walukeshwar* meaning Sandgod.

Babulnath Temple.—This is picturesquely situated on the eastern side of Malabar Hill and is a recent structure completed in 1900. The original Babulnath was built about the year 1780.

Mahaluxmi Temple at Breach Candy is a simple shrine which was built by the contractor of the Hornby Vellard. Near by stands *Dhakji's Temple*, a prominent structure, which is visible twenty-five miles out at sea.

Prabhadevi Temple.—The original temple was built by Raja Bimb of Mahim in honour of his family goddess, but was destroyed by the Muhammadans when they conquered Mahim. The present temple which is on the Prabhadevi Road at Mahim was, according to the inscription on the temple wall, built "by the entire Prabhu Community" in the year 1714.

Other Places of Worship.—There are Synagogues in the Fort and Byculla districts. A Bene-Israel Synagogue in Mandvi dates from 1796.

The Theistic Church of the Bombay Prarthana Samaj is in Girgaum.

SCIENTIFIC AND TECHNICAL

* BOMBAY BACTERIOLOGICAL LABORATORY

has recently been renamed as the Haffkine Institute after the founder. The laboratories have always been the principal centre of bacteriological work of every kind and its activities are described in some detail in a special article on the subject on page 99.

* COLABA AND ALIBAG OBSERVATORIES.

It was in the year 1823 that the present site of the Colaba Observatory was selected and the ground enclosed under the direction of the East India Company. The main building was erected in 1826 under the supervision of Mr. Curnin, the first Astronomer at Bombay. The first fifteen years were marked by a period of inactivity. The instruments supplied to Mr. Curnin were found defective and shipped back to England. In 1835, the Observatory was assigned as a dwelling house to Mr. Orlebar, Professor of Astronomy in the Elphinstone College, and a few instruments were placed at his disposal. No meteorological or magnetical observations taken before 1841 are however on record. On the recommendation of the Royal Society systematic observations began in that year and the Observatory was associated in the prosecution of research in meteorology and magnetism (besides continuing its astronomical work) with the colonial observatories of Toronto, Habarton, St. Helena, Singapore, the Cape of Good Hope, and with the Indian Observatories at Simla and Madras. From this year the active life of the Observatory may be said to have commenced. In 1842, Mr. Orlebar was succeeded by Dr. Buist, but the appointment of Astronomer at the Observatory was subsequently held by officers of Her Majesty's Navy stationed at Bombay. This arrangement continued till 1864, during which period continuous records of astronomical, magnetical and meteorological observations were secured. But the work was not wholly satisfactory; the generally defective condition of the equipment of the Observatory resulted in the appointment by Government of a committee of inquiry which, after a full investigation, recommended that (1) a full equipment comprising the latest type of recording instruments should be procured, and (2) a full time and fully qualified officer should be appointed as Director. These recommendations were at once acted upon, and Mr. C. Chambers, F.R.S. was selected as the first Director in 1865. The change thus initiated has more than fulfilled the anticipations which were then formed regarding the utility of the Observatory, which now claims to be recognised as a first class Institution with well-established reputation in the scientific world. Both the magnetical and meteorological branches were, as recommended, fully equipped with photographic and mechanically self-recording instruments and with other auxiliary instruments for eye observations. The activity of the Observatory under Mr. Chambers' regime is apparent from the papers published by him in scientific journals and the volumes issued by the Observatory during the years 1865 to 1894, which contain valuable contributions to the science of meteorology and magnetism. On the death of Mr. Chambers in February 1896, Dr. N. A. F. Moos was appointed to fill the vacancy.

In view of a general scheme for the imperialization of the Indian Observatories submitted to the Government of India which recommended the reduction of the Bombay Observatory to a second class Observatory making it only a recording station, the Secretary of State in 1898 deputed the Astronomer Royal Sir W. Christie and Sir Norman Lockyer to inspect the Observatory and submit a report. As a result of their visit, the Bombay Observatory, which had up to then worked independently under the control of the Bombay Government, was transferred to the Government of India and placed under the administrative control of the Director-General of Observatories. It was decided that the Observatory should continue as a first class Institution and should not be reduced to a mere recording Institution.

In connection with the International scheme initiated by the British Association for the Advancement of Science for the prosecution of enquiry in the science of seismology, the Observatory was selected as one of the Institutions for partaking in this activity.

Early in 1900, when the city of Bombay decided to employ electricity as motive power for its street tram service, it became necessary to remove the magnetic work from Colaba to a place free from artificial disturbances and a new Magnetic Observatory was consequently built up at Alibag some 18 miles to the south-east of Bombay. It was far away, enough to be beyond the disturbing effects of the electric lines in Bombay, but sufficiently near, presumably, to have similar magnetic conditions. The site was secured in 1902, and the construction of the buildings was completed in 1903. The Observatory was equipped with a full set of new magnetic instruments and comparative observations commenced in April, 1904. After securing an undisturbed duplicate record extending over a period of two years, the magnetic work at Colaba was stopped on 31st March 1906, fortunately before the electric tram service was completed and had commenced its operation. Dr. Moos published the two volumes entitled the 'Colaba Magnetic Data' which formed a comprehensive study of the continuous magnetic records obtained in the Colaba Observatory during the sixty years-1846 to 1905. On the retirement of Dr. Moos in 1919, the Office of the Director was filled up for short periods by Dr. C. W. B. Normand and Mr. T. K. Chinmayanandam and from 1922 by Dr. S. K. Banerji.

A few years after the appointment of Mr. C. Chambers, as Director of the Observatory, the Government of Bombay created the post of Meteorological Reporter to the Government of Bombay, and located this officer, his staff and office at the Observatory. Mr. Frederic Chambers was appointed as the

first Reporter and associated himself with Mr. C. Chambers in meteorological and magnetical investigations. In 1888 the post of the local meteorological reporter was reduced to a half-time appointment and placed under the control of the Imperial Meteorological Reporter. The local Superintendent of Telegraphs was appointed in this half-time post and his office transferred to the Telegraph buildings. This arrangement made in 1888 remained in force till April 1923 when the Office of the Meteorologist was again transferred to the Colaba Observatory. The half-time post of the Meteorologist was abolished and his office amalgamated with that of the Director, Bombay and Alibag Observatories, who was thereafter designated as 'Meteorologist, Bombay.'

The appliances and powers of the observatories at Colaba and Alibag are directed first to the prosecution of enquiries into the sciences of terrestrial magnetism, meteorology, and seismology; secondly, to the publication of recorded facts and observations, their reduction and discussion and to the distribution of such publications amongst the learned societies and men of science in all parts of the world; and thirdly, to astronomical observations for the purposes of time-keeping and to the signalling of time for the purposes of navigation. With these objects in view, the observatories are equipped with various magnetical, meteorological, astronomical and seismological instruments installed in separate buildings, especially constructed for their accommodation.

The routine operations of the Observatory and the Meteorological Office consist in maintaining in continuous action the autographic instruments (magnetical, meteorological and seismographic); in taking eye observations five times a day of these instruments; in taking a regular series of observations for determining the absolute values of the various magnetic elements; in reducing the data thus secured and in putting them into the proper form for publication and investigations; in publishing a daily weather report; in collecting data for marine meteorology; in supplying weather and other reports to several officers and men of science, and in furnishing the requisite information on magnetical, meteorological, seismological and other allied questions to Government Officers and others. In the astronomical department the observations of the stars or the sun are made with sufficient frequency for the correct rating of the large number of chronometers kept in store for issuing to ships belonging to the Royal Indian Marine and the Royal Navy and for directing the falls of the time-signal balls on the towers at the Castle and the Prince's Dock. Wireless time-signals from the various time transmitting stations, particularly Eiffel Tower and Nauen, are regularly received in the Observatory and compared with the local time.

The principal publications issued by the Observatory are :—

- (1) Bombay Magnetical, Meteorological and Seismographic Observations, Forty-two Volumes.
- (2) Meteorology of the Bombay Presidency.
- (3) Colaba Magnetic Data, Two Volumes.
- (4) Magnetic Disturbance Charts, 1905-1915.
- (5) Rainfall in the Bombay Presidency, Six Volumes.
- (6) Numerous papers published in the Proceedings of the Royal Society, Philosophical Transactions of Royal Society, Philosophical Magazine, Terrestrial Magnetism and Atmospheric Electricity, Nature, etc.

S. K. BANERJI.

* THE MINT.

The first Mint for coining rupees and pies was established by Gerald Aungier in 1670, but the money was not accepted even at Surat "nor in any part of the Great Moghuls' dominions or in any part of the territories of the Indian Kings ; only it passed among the English in their fort, and some two or three leagues up in the country, and in the villages along the coast." The present building was designed by Major Hawkins, R.E., and completed in 1829. The offices of the Mint Master and Assay Master are on the upper floor while the ground floor accommodates the Bullion Department.

* The north end is occupied by the Silver and Nickel melting departments and the General Workshop, while the various coining departments are at the southern end.

The Mint machinery till recently was driven by steam engines, but these were replaced by electric motors by which all the plant is now driven. Electric energy on the 3 phase A. C. system is supplied in bulk at high tension by the Bombay Electric Supply Co., to a transforming sub-station, in which it is transformed down to 400 volts ; the current at this pressure is led to a main switchboard situated centrally in the Mint, and is led thence by feeder cables to the various groups of motors, each feeder being controlled by an oil switch ; static condensers are used, close to the main switchboard, to improve the power factor of the installation ; the motors are of the induction type.

The Mint has a normal capacity, working without overtime, of about 6 lakhs of rupees and 3 to 4 lakhs of small coin per diem. The amount of work, however, varies very greatly from time to

time in accordance with the coinage requirements of the country. At the end of the war, there was a very large demand for Indian Government coin, and the Mint was therefore put on to working overtime and night work, namely, 20 hours a day ; during this period the output was about 14 lakhs of rupees and 7 lakhs of cupro-nickel coins per day ; the Calcutta Mint, which is a little larger than the Bombay Mint, was similarly required to coin as fast as possible ; the approximate outputs of all coins for the years 1918-19 and 1919-20 by the two Mints were as follows :

	<i>Bombay Mint.</i>	<i>Calcutta Mint.</i>
1918-19 ..	358 millions.	546 millions.
1919-20 ..	375 millions.	510 millions.

These outputs are believed to be very considerably greater than has ever been achieved by any other Mint.

In addition to Indian Government coinage, for which the Indian Mints are primarily intended, coinage for foreign Governments is sometimes undertaken, for instance, Straits Settlements, Ceylon and British Hongkong Dollars ; coinage was also carried out for the Egyptian Government some years ago.

When the gold 15 rupee piece was introduced, this was coined in the Bombay Mint, but only a small quantity (about 2 million pieces) was done, as this coin was abolished shortly after. No gold coinage is carried out at present.

At present no rupees are being coined and the Mint is working at a very low output, on small coin, such as $\frac{1}{4}$ rupees, cupro-nickel 2-anna and 1-anna pieces, single pice, and pies. The output at present is only about 2 lakhs of pieces a day.

The processes of coining are roughly as follows :—(i) Alligating and binding the pots, *i.e.*, calculating and weighing in the proper proportions the metals to be melted together in each crucible so as to get the correct alloys for the various coins : thus, rupees have 11 parts of silver to 1 of copper, (ii) Melting and pouring the metal into suitable bars. As there is a good deal of scrap left when cutting out the coin banks, it is always necessary to melt a greater weight of metal than the weight of coin produced. For rupees the metal melted has to be about 50 per cent. more than the weight of coin produced. Thus for one lakh of rupees, the metal melted has to be about $1\frac{3}{4}$ tons. (iii) Rolling into straps, (iv) Cutting out blanks and edging, (v) Weighing blanks, (vi) Annealing, (vii) Stamping, (viii) Examining, (ix) Packing.

* THE SIR J. J. SCHOOL OF ART, BOMBAY.

This institution is under the Educational Department of the Government of Bombay and was established in 1857 in a temporary building. The present school for Drawing and Painting and Modelling, and for the Normal Training Class for Drawing Teachers was built in 1878. The Reay Art Workshops were constructed in 1892 and the Sir George Clarke Technical Laboratory and Studios in which the pottery laboratory and Architectural School are accommodated were erected in 1907. The School of Art holds courses of study covering a period of five years in Drawing and Painting, Modelling, Architecture and Design. The courses of study in Mural Decoration are attended by a selected number of students who have completed five years study in Drawing and Painting. Admission to the Normal Training Class for Drawing Teachers is granted on a competitive Examination to a limited number of students. The successful candidates at the Diploma Examinations of the various Sections of the School of Arts are allowed to affix to their names the designations G. D. (Art), G. D. (Arch), G. D. (Modelling) and A. M. as sanctioned by the Government of Bombay. In the Workshops instruction is given in Cabinet making, Wood and Stone Carving, Metal work, House Decoration and Carpet Weaving. For students interested in the improvement of the Pottery industry, there is a special laboratory and Studio. An Art Museum and an Art Library are attached to the School and contain specimens of European and Indian Art and valuable books. The School of Art has its own Gymkhana Club.

W. E. G. SOLOMON.

* THE ROYAL INSTITUTE OF SCIENCE, BOMBAY.

Lord Sydenham, addressing the Convocation of the University of Bombay on the 18th February 1908, made his appeal to the public in behalf of the scheme for a Research Institute of Science. This appeal met with very generous support: Sir Cawasji Jehangir led the way with a donation of Rs. 4 lakhs for the Institute and separate donations of Rs. 3¼ lakhs for the building of the Sir Cawasji Jehangir Public Hall and Rs. ¾ lakh as an endowment for its maintenance: Sir Jacob Sassoon gave Rs. 10 lakhs, Sir Currimbhai Ebrahim gave Rs. 4½ lakhs and the late Sir Vasanji Trikamji Mulji gave Rs. 2½ lakhs for the Library. Government contributed Rs. 5 lakhs from the provincial funds: the University gave Rs. 1 lakh towards the cost of building the East Wing in return for the right of using the same for certain University purposes, but this arrangement had its disadvantages and subsequently it was cancelled by mutual agreement and the

contribution was returned by the Government to the University. Thus the funds actually available inclusive of accumulated interest and capital were about Rs. 32 lakhs. Out of this sum Rs. 1 lakh is reserved by the terms of Sir Currimbhai Ebrahim's bequest for scholarships for Muhammedan students in the Institute.

The plans of the building were drawn by Mr. G. Wittet, at that time Consulting Architect to Government, the foundation stone was laid by Lord Sydenham on the 5th April 1911 and on the occasion of the visit of His Majesty the King Emperor the designation "Royal" was added to its previous title. The buildings were approximately complete and ready about the end of 1915, but the War claimed the Institute Buildings at that moment and it did splendid service as a War Hospital for about four years. In the year 1920 the Principal and some members of the staff were appointed and the work of teaching was, at least nominally, started in June. The Institute was, however, formally opened at a later date by H. E. the Governor Sir Leslie Wilson on the 27th of March 1924.

Of the original Rs. 32 lakhs about Rs. 13·9 lakhs were spent on buildings, about Rs. 4·6 lakhs on permanent equipment like gas, water and electric installations and about Rs. 3·4 lakhs have been utilized in purchasing apparatus, chemicals, books, etc., during the last five years.

Although the Institute commenced its teaching work in 1920, it could do so only under extraordinary great difficulties which only science men can understand, because there were no laboratories and the work of installing furniture, pipings of all sorts, electrical and other fittings had to be carried on simultaneously; likewise apparatus had to be obtained. In spite of the heavy handicaps due to severe financial stringency and general disorganization of industry, which made some articles unprocurable and also the fluctuations of the exchange, gradual improvement, step by step, enabled the Institute to be developed and by the end of 1923-24, it had reached a point of performing, more or less satisfactorily, many of the functions for which the Institute was founded. Finally in the session 1924-25 the staff and resources of the Institute were approximately on a scale suitable for the advancement of knowledge by scientific research in all its departments.

The Institute, at present, maintains departments of Physics, Applied Mathematics, Organic and General Chemistry, Botany and Zoology. The Institute possesses a fairly good reference library and it would not be an exaggeration to say that on this side of India there had been really no general science library before the foundation of this Institute. There is also a workshop attached to the Institute and it is fitted up with simpler implements, for wood and metal work, where students can practice and also receive instructions. The workshop also possesses a finer

set of precision tools for the use of skilled laboratory men where-with they could construct the better type of research apparatus according to designs or carry out fine repairs. There are attached to the workshop a glass-blowing room and a photography room.

The Institute is endeavouring to take the lead in this presidency in helping to spread among the people, as a whole, an appreciation of the methods and achievements of science and a well-founded confidence in the pursuit of some scientific research for its own sake, in the hope that knowledge is for the good of mankind and whether or not it gives immediate, ultimate or remote profit. The Institute possesses to a certain extent most of the necessary equipment, staff, literature and laboratories. It has endeavoured to provide facilities and atmosphere of research with a view to induce and assist those who want to add to the store of human knowledge by original contributions and discovery.

G. R. PARANJPE.

* VICTORIA JUBILEE TECHNICAL INSTITUTE.

THE Victoria Jubilee Technical Institute was founded largely through the princely munificence of Sir Dinshaw Manockji Petit, Baronet, in 1888 and was located in the old Elphinstone College buildings at Byculla and the courses were for Mechanical Engineering and Textile Manufacture.

Early in the present century a course in Electrical Engineering was started and a few years later a course in Technical and Applied Chemistry. In 1913 the school for Sheet Metal and Enamelling was converted into the school for Sanitary Engineering and Plumbing.

It was found that with the increased number of subjects and the increased number of students the accommodation was insufficient more especially as the Bombay Improvement Trust required a strip of land on the east and the G. I. P. Railway required a strip on the west of the Institute compound. The Government of Bombay came to the assistance of the Institute so that it was possible to obtain a site of approximately 16 acres in Matunga and erect new buildings. The Institute moved into its new quarters in 1923.

In addition to the 5 branches of technology attended by students for a 4 years' course, the Institute conducts classes for apprentices in the railways, mills and for electrical wiremen, on Saturday mornings. These classes are attended by a large number of students and are supplying a real need as they cater for men who are earning their own living and have only a short time at their disposal for theoretical technical training.

A. J. TURNER.

Queen Mary Technical School for Disabled Indian Soldiers, was established in 1917 through the efforts of H. E. Lady Willingdon and is located in the Braganza Hall at Byculla. The object of the school is to take over for a period of six months or more Indian soldiers and followers of all ranks and classes who have been invalided out of the service as unfit for further military duty, and to teach them trades so that after a course of training they will have means of supplementing their pensions and live in comparative comfort. The following trades are taught:— (1) Tailoring, (2) Motor car driving and mechanics, (3) Hosiery making, (4) Oil engine driving, (5) Elementary engineering, fitting, turning and moulding, (6) Cinema operating. Each man is at liberty to choose the trade he wishes to learn, and at the end of the prescribed course, he is examined and provided with a diploma on passing the necessary examination. Men turned out from this school have been able to earn from Rs. 20 to Rs. 75 per month. Lately a voluntary class has been opened in colloquial English and Elementary reading and writing. Entertainments and amusements such as conjuring shows, harmoniums, indoor and outdoor games are provided. Occasionally the men are taken to the local theatres, the Victoria Gardens, and other places of amusement.

The School for the Blind, under the control of the American Marathi Mission, was established in 1900 at Dadar. The present number on the roll is 50, 25 boys and 25 girls. The ordinary school branches are taught along with music, cane-work and beadwork.

Victoria Memorial School for the Blind.—This school was established in memory of the late Queen Empress Victoria and is situated at Tardeo Road. It is both an asylum and a school. It opened on the 13th December 1902, under the Principalship of Dr. Nilkanthrai D. Chhatrapati, L.M.S., himself blind, who was invited to come down from Ahmedabad with his whole school of thirteen pupils. It has on its roll now sixty pupils. The institution teaches Gujarati, Marathi and English Braille-reading and writing, besides arithmetic, geography, object and general lessons. Music, vocal and instrumental, tailoring, tape-weaving, bidee-making and cane and bamboo work form its chief industrial studies. It has an extensive compound, a well lighted and well ventilated commodious building with arrangement for drill and gymnastics. Every new pupil is, before admission, examined by the Ophthalmic Surgeon at the Sir C. J. Ophthalmic Hospital, and some have vision restored. The school thus restores sight to such as can have it. The incurables are then put on the regular roll and educated to make themselves self-supporting, healthy and useful citizens.

The institution is aided by Government and the Bombay Municipality, besides other philanthropic bodies and individuals.

Besides the buildings for the school and asylum and the quarters for the Principal, Manager, etc., the school has a fund of Rs. 1,75,900 wholly invested in Government securities in the names of the Trustees. There is a strong and representative committee of management and the Hon'ble Sir Norman C. Macleod, Kt., Chief Justice of Bombay, is the Chairman.

The Bombay Institution for Deaf-Mutes, at Nesbit Road, Mazgaon, was founded by the late Bishop Meurin in 1885. Deaf-mutes of all creed are admitted and instructions are given in articulation, lip-reading, arithmetic, grammar, geography, drawing and carpentry. Education is afforded gratis.

The David Sassoon Industrial and Reformatory Institution is intended to reform juvenile offenders and to train them to habits of useful industry. Various useful subjects are taught including black-smithy, carpentry, carriage-building, painting, tailoring, brass-moulding, turning in wood and iron, spinning, weaving and gardening.

INDIAN COTTON COMMITTEE'S TECHNOLOGICAL LABORATORY.

These newly opened laboratories provide ample space, apparatus and special facilities for carrying out physical, botanical, physiological and agricultural investigations on cotton. The spinning laboratory contains various appliances for conducting spinning tests on different samples of cotton with a view to determine the bearing of the numerous measurable characters of cotton-fibre on spinning value. (For detailed description of the activities of these laboratories see note on page 101.)

MUNICIPAL NOTES.

Crawford Market.—This market which is situated near the junction of Esplanade and Carnac roads is called Crawford Market after the name of the late Mr. Arthur Crawford, the then Municipal Commissioner and was built in the year 1865 at a cost of Rs. 7,08,357. It is divided into several sections in different buildings. The Fruit, Vegetable and Grocery section is a large building facing the roadway. It comprises 650 stalls. The central part of the building has two floors and a tower with a large clock on four sides, which is a great convenience to the public. This clock shows the Local Time which is about 39 minutes behind the standard time. A portion of the first floor is used as Market Office, the remainder being occupied by the Superintendent of Markets, as it is incumbent on him to remain on the premises. In order to observe the religious rights of the Hindus, this building is so conducted that meat,

fish, &c., exposed for sale in other sections of the market, which are in the compound, are not exposed to view from any part of the building. There are separate buildings for mutton, beef, fish, fowls, &c. They are as under:—A building used as mutton and fish section—comprising 119 mutton stalls with a large area for fisherwomen. A building—for beef—comprising 81 stalls; this section is enclosed on all sides, so that the beef carcasses may not be seen from outside. A building is used for mincers and head or liver sellers and comprises 68 stalls. A building containing 27 godowns is reserved for storage of goods belonging to the stall holders, and there are separate buildings for fowls and bird shops. The market is open from 3-45 a.m. to 10 p.m. and the total income from the whole market is about Rs. 1,31,000.

L. W. MICHAEL.

Water Supply.—In olden times Bombay depended for its water supply upon wells and tanks which however were extremely liable to pollution from insanitary surroundings.

In 1856, the Vihar Lake was constructed and water brought into Bombay by means of pipes, the daily supply amounting to $9\frac{1}{2}$ million gallons. This, however, owing to the increasing population proved within a few years quite insufficient for the requirements of the city.

In 1872 therefore another scheme was launched and a new lake constructed at Tulsi in 1879, with filter beds for it on Malabar Hill. The additional supply thus obtained amounted to $4\frac{1}{2}$ million gallons per day. A reservoir with filter beds for the Vehar water was also erected on Bhundarwada Hill at Mazagon.

By 1884 even the total yield of Tulsi and Vehar, amounting to 14 million gallons a day, proved totally insufficient for the requirements of the city. Consequently the construction of a lake at Tansa at the foot of the Western Ghats, and about 55 miles from Bombay, was commenced in 1886. During the building of the dam for this lake a famine, which threatened in the year 1889, led to the construction of a small lake at Pawai, near Vehar; but the low level of this lake did not permit of proper gravitation into the city, and moreover, as the water was unsatisfactory the lake was abandoned on the completion of the Tansa scheme in 1892. The Tansa lake yields a daily supply of $17\frac{1}{4}$ million gallons. The supply mains from this lake have lately been duplicated owing to the increasing demand of water for trade and other purposes.

* Another scheme was recently launched by the Municipality to further increase the supply of water from the Tansa by means of a new pipe-line. The good results of this undertaking are already visible in the fact that water is supplied in most parts of Bombay now for all the twenty-four hours of the day.

The new water-supply installed for the city of Bombay is derived from Lake Tansa, 55 miles from the city, and is conveyed by two pipes, each 6 ft. in diameter from Tansa to Powai. Thence the supply passes into three pipes, two of them being 57 inches in diameter which continues to Bombay ; and the third of 60 inches diameter which is laid to Ghatkopar, will be connected with the two existing 48 inches diameter Tansa mains, the whole combination forming the largest and longest pipe-line ever laid. Antiquity has no parallel to this, and its nearest rival is in the New World. The city of New York obtains its water from a source 50 miles distant. The supplies of Liverpool, Manchester, and Birmingham have farther to come, but they are conveyed partly in open channels.

The new and old pipes will convey a water-supply to Bombay of 90,000,000 galls. per day, and the arrangement provided is capable of expansion to 160,000,000 galls. per day without alteration to any of the existing pipe-lines outside Bombay. In a tropical city the demand for water is naturally greater than in a temperate zone. London uses 35 galls. daily per head of population ; the consumption in Bombay under the existing unaugmented system is 41 galls. per day, and it is found insufficient. When the new supply is available as it will be in 1926, the estimated consumption will be 78 galls. per day per head of population including men, women, and children.

PROTECTION FROM RUST.

Very keen competition entered into the tendering for this enormous pipe-line, the weight of steel in which is 80,000 tons. Engineering firms specialising in steel-pipe manufacture from all parts of the world vied with each other for this large undertaking. At the time the tenders were received the steel market in Britain was in a very unsettled condition and in a ferment of labour trouble. Messrs. Braithwaite and Co. made a bold bid for the work by co-operating with Messrs. Dorman Long and Co., Ltd., and arranging to place the supplying of the steel plates in their hands if they should prove successful. This resulted in their tender being accepted. The permanent protection of pipes from rust, with the climate difficulties which existed to accentuate the risks, constituted a problem in itself. It was solved by the adoption of the well-known proprietary enamel "Bowranite," for a supply of which contracts calling for the delivery of 20 tons monthly were entered into with Messrs. Robert Bowran and Co., Ltd., of Newcastle-on-Tyne.

So far as price affected the placing of the contract it was the device of fabricating the pipes on the spot from steel plates and the resulting economy in the cost of freight from England to Bombay which led to some substantial savings. The difference between

the cost of transporting from England to India 80,000 tons of flat steel plates and the same weight of pipes 6 ft. in diameter, amounted to the saving of three-fifths of the cost of transport and handling of the latter. After deducting the cost of establishing the Mulund Works, there was a net saving of 30 lakhs of rupees to the Municipality.

CONTROLLING THE PRESSURE.

The city of Bombay obtains its existing water-supply through 3 ft. and 4 ft. pipes, laid upon a route of cuttings and embankments, and in general terms the same route has been adopted for the new pipe-lines, except that additional bridges were required and some embankments needed to be widened. The embankments also needed to be sufficiently consolidated to carry the extra weight, for the double line of new pipes, when filled with water, is eight times heavier than the single 3 ft. line. The excavation and embankment work were carried out by the Tata Construction Co., who co-operated for the Municipality with Messrs. Braithwaite. The new 6-ft. diameter pipes will stretch in duplicate from Lake Tansa to Powai, and thence into the city of Bombay three new smaller pipes are provided, one being of 60 inches diameter and two others of 57 inches. This change in diameter is due to the need of controlling the pressure of the supply when it reaches the city.

When the original scheme for obtaining water from Lake Tansa was planned in 1872, the barrage at Tansa was constructed on such a scale as to provide for very large future needs. The dam at Tansa has been raised by about 6 ft., but beyond this it has not been necessary to do anything to increase the catchment basin or storage capacity at the Lake, which now holds 35,000,000,000 galls. An enormous amount of work has had to be carried out to widen and strengthen the track between Tansa and Bombay island. In the course of the necessary excavation, amounting to 72,000,000 cub. ft., various kinds of material were encountered, rock, sand, clay, and much of it through the jungle. The unhealthy nature of the country, and the climatic conditions, made it possible only to work on the track six months out of twelve. The bridge-work was of an important character, and was pushed on in order to facilitate the conveyance of the piping. The existing Kasheli bridge was not found to be strong enough for the conveyance of the necessary loads, and it was therefore strengthened as a preliminary undertaking.

The Bassein Creek at the point to be crossed near Kasheli was 1,800 ft. wide, and it was decided to adopt 13 spans of 138 ft. 6 in. as most economical and practical. The bridge had to carry two pipes 72 inches diameter and to provide for a third at some future date. It was considered desirable to provide a light

railway, also a road to link up the Bombay-Agra Road and so save a detour of 14 miles. The bridge is 62 ft. wide, 36 ft. between main girders and with cantilevers for pipe-carrying outside the main girders. One pipe is carried between the girders, also a 24-ft. clear roadway.

FABRICATING THE PIPES.

The 80,000 stons of flat teel plates required for the contract were supplied by Messrs. Dorman, Long and Co., Ltd., from their Redcar works, and were planed and scarfed by them before shipment. All the rivet-holes for jointing the pipes were drilled to a total number of 40,000,000. So accurately were these holes drilled to template, both as to size and position, that no adjustment—not even any reaming of the holes—was necessary when the plates arrived at Mulund. The longitudinal joints after the plates were bent, were found in all cases to fit exactly but what is more remarkable is the fact that when the resulting circular joints of the pipes were fitted in, end to end, they gave no trouble at all, notwithstanding that the joints are staggered. That is to say, the longitudinal joints, as laid, are not allowed to be in the same straight line on two adjacent pipes.

After the longitudinal seam has been riveted, the pipe section resembles a circular tank a little more than 7 ft. long and 6 ft. in diameter. The process of jointing the pipes was facilitated by a rotating cradle device, and was greatly aided by the accuracy in which the edges of the steel were prepared before leaving England. The sections are temporarily bolted through every alternate hole before riveting. When eight lengths of pipe have been riveted the whole section is moved by means of a 10-ton crane to a caulking bay, and rests on a rotating stallway. The caulkers then proceed to make each seam watertight by means of pneumatically driven caulking tools. This complete operation is so planned that the standardised length of 57 ft. 4 in. of jointed pipe can be completely caulked by three men in a working day of eight hours, each man caulking 25 ft. per hour. The caulkers' operation proceeds with the utmost regularity, the pipe being rotated at a fixed speed, so that the caulking tool is always in its handiest position.

Immediately the inside of the section has been caulked, with the exception of about 12 inches at each end to allow a clean joint to be riveted in the field, it is sprayed with "Bowranite." This bituminous composition has been proved by exhaustive practical and scientific tests to be the best preservative agent where rust is a problem to be met. The "Bowranite" is applied by hand with brushes or by pneumatic sprays, manufactured by the Consolidated Pneumatic Tool Co., and to make the

spraying operation in no way injurious to the worker, a current of air is driven through the pipe during the spraying process.

Specimen-caulked pipes are tested to withstand a pressure of 150 lb. per sq. in., and when a long length (4½ miles) of pipeline, needing seven days to fill with water, was actually tested at the pressure after completion, the leaks due to defective caulking were negligible.

A 10-ton crane is used for picking up the 57-ft. section at the caulking bay. Similar cranes afterwards load the sections on to bolster railway trucks. From eight to ten of the completed sections are ultimately loaded up on to a train for conveyance to the site. Six locomotives and 232 bolster wagons were provided for this purpose.—“Times of India—Engineering Supplement.”

* DRAINAGE OF BOMBAY.

The drainage of Bombay has been carried out on the dual system, *i. e.*, there is one set of drains for the disposal of surface or storm-waters, and another set of sewers for the disposal of sewage. The formation of the City is somewhat like a saucer with its rim or outer extremity at a higher level, and its interior lying in a large hollow. Thus a great part of the Island lies below the level of the Highest High Water Spring Tides. For the purpose of storm-water drainage, all lands lying above this level are termed High Lands, and they are drained by storm-water drains discharging directly either into the open sea on the West or into the harbour on the East at different points.

All lands lying below the level of the Highest High Water Spring Tides are termed Low Lands. The southern portions of these lands, *i. e.*, upto Bellasis Road, are drained through the old main drain which runs from Bellasis Road to Love Grove, and into which a number of covered storm-water drains from different parts of the southern low lands discharge. The central and the northern portions of the Low Lands discharge into the sea near the Worli Fort, through what are called Low Level Channels. Both the outlets at Love Grove and at Worli are provided with wooden sluice gates fixed into masonry, and these gates are opened during the ebb tides and closed at high tides during the rainy season. During the fair season, they are entirely closed.

From the above description, it will be seen that while there are few chances of flooding taking place in the high lands, the chances of flooding in the low lands are greater, as it might

happen that when the gates are shut and the tide is high, we might have a heavy rainfall. It is proposed to have a pumping plant at Love Grove to pump the storm-water into the sea when there is a heavy rainfall at high tides.

As regards sewers, the main sewer of Bombay is of masonry and is ovoid in section. It commences at the Town Hall and runs through the heart of the City and the flats to Love Grove, receiving tributary ovoid sewers and a number of pipe sewers from different parts of the City. The whole of the City south of Elphinstone Road Station has been sewerred, and the whole of the sewage is conveyed by the sewers to Love Grove, where it is pumped into the sea through an outfall sewer, which consists of two barrels, each 6 feet in diameter. The outfall sewer is carried to about a quarter of a mile into the sea. Owing to the peculiar configuration of the Island, the sewage from certain low lying districts of the City cannot flow by gravitation into the main sewers, and therefore in these districts the sewage is lifted by local pumping under the Shone system. In this system the sewage flows to a central point, where there is a chamber containing two or more ejectors, and when they are full, air under pressure is admitted automatically which forces the sewage through a rising main to the point of discharge into some convenient gravitating sewer. Ultimately the whole of this sewage finds its way through the main sewers to Love Grove. Before the sewage at Love Grove passes through the pumping engines, it is made to go through a screening and dredging chamber, where both heavy and floating materials are arrested. The pumping station consists of 4 Beam engines, each capable of lifting million gallons per day through a maximum lift of 27 feet.

In recent years there has been a good deal of consideration and discussion regarding the sewage outfall of the City, including the northern undrained parts of the Island. After a good deal of discussion, it has now been practically decided to have 3 sewage outfalls, one at Colaba beyond the Prong's Light House for the whole of the Colaba District and the portion of the Fort upto Church Gate Street. The whole of the remaining southern part of the Island, as far north as Elphinstone Road Station, will drain through the present outfall at Love Grove. The third outfall will be for the northern portion of the City, North of Elphinstone Road Station, and will be located near the Antope Hill, and the sewage will be discharged into the Kurla Creek after being purified on the Activated Sludge Process.

D. D. DARUWALA.

* ANTI-MALARIAL OPERATIONS IN BOMBAY.

The mosquito malaria theory was accepted in 1900 and ever since, the Health Department has been actively carrying out the measures for the extermination of malaria from the City. The difficult nature of the task was reported by Dr. J. A. Turner to the Corporation in the following words :—

“ To get rid of the larvæ from every haunt of the mosquito all at once is, however, a vast undertaking and would require a large staff and expenditure ; but the continued efforts of the Health and Engineer’s Departments, combined with a spread of the knowledge of the subject amongst the population should do a great deal in mitigating the evil.”
(19-12-1901).

During the third quarter of 1908, a wave of malaria severer than usual swept over Bombay, along with the rest of India and at the request of the Corporation, Government appointed Malaria Expert to inquire into the causes of the prevalence of malaria in the City and suggest a remedy. Dr. Charles Bentley submitted his interesting report and in 1911, Government invited the Corporation to carry through the operation to success without delay and promised to give steady support to their endeavours. As a result a Special Malaria Department was created under the Health Officer and vigorous measures were taken to get rid of the breeding places in the City.

In 1913 the Municipal Act was amended to give more adequate powers to deal with places breeding or likely to breed mosquitoes and under those powers extensive works have been carried out.

Many thousands of wells and cisterns have been covered, a complete record of all wells and cisterns in the City have been made and is from time to time revised, and annual estimates of the prevalence of malaria have been made by the periodical examination of children in various parts of the City.

The City is divided into 7 Wards and each Ward into Sections, each Section in charge of a trained Overseer. The Overseer inspects daily a part of his Section regularly and systematically. During the inspection a thorough search is made for all likely breeding places which are dealt with as necessary either by using a larvicide or by more permanent measures.

The staff engaged in the anti-malarial operations consists at present of 5 Malaria Inspectors, 38 Overseers, 1 Mason, 1 Carpenter and 70 Bigaries (Hamals) and is to be increased considerably next year.

All unserviceable articles such as bottles, tins, pots, etc., likely to hold water are removed. Tubs, buckets holding water are frequently emptied and catch-pits and storm-water entrances

frequently treated with larvicide. The hollows of the trees are filled in with sand and cement as they are frequently found breeding. Tanks, wells, cisterns are frequently inspected and when found breeding, are treated with larvicides wherever possible or legal action taken against the owner to prevent breeding.

Malaria Department can and does prevent breeding of mosquitoes in open areas, cisterns, etc., but the prevention of breeding within the houses is a difficult task until the occupants of the house become the willing volunteers of the Malaria Department. The control of Malaria, after all, is in the hands of the individual householder whose co-operation is essential if unnecessary sickness and suffering is to be avoided.

In 1920, the attention of the Municipality and of Government was called to the danger which had so notoriously attended reclamation operations in the past in various parts of the world and in the City of Bombay and of the likelihood of epidemic malaria resulting from the reclamation of Back Bay in the absence of special anti-malarial precautions. The reclamation scheme consists of the construction of a massive sea-wall extending from near Marine Lines Station to Colaba Point, about four miles long, and of filling in the area thus enclosed between the sea-wall and the present land margin with material obtained by dredging in the harbour or in Back Bay itself, and pumping the dredged material through pipe lines to the area to be reclaimed.

An area of 1,145 acres is thus to be reclaimed from the sea and added on to the City of Bombay. The construction of the sea-wall was commenced in the year 1921 and dredging operations began from December 1923. The actual conditions relative to the breeding of anopheles on the surface of the dredged material in the course of various stages of solidification and settling depend to a great extent on the character and porosity of such material; there is also to be considered pool formation in connection with dredging and rain water collections on the newly created land surface, besides the ordinary concomitants of large engineering works of this nature which give rise to a variety of breeding sources, and these will be dealt with in detail at the time of describing the breeding grounds of the reclamation.

The growth of the City of Bombay consists of a series of reclamation commencing as far back as 1835. While some of these reclamation works have been associated with increased incidence of malaria, others do not seem to have been connected with any special Malarial outbreaks, and Dr. Bentley ascribes this freedom to the following reasons:—

- (1) No serious centres of Malaria infection existed in the vicinity of the works.

(2) That few permanent breeding places were present.

(3) That the labourers were not encamped on the site of the works.

But in the present reclamation scheme, permanent breeding places are in considerable numbers, the labourers are encamped on the site of the works and as some of these gangs are imported from highly malarious districts they constitute a suitable focus of infection.

Therefore to advise the Government of Bombay as to the sanitary precautions to be taken in connection with the present reclamation scheme, a committee composed of eminent medical men in the City was appointed and they gave it as their considered opinion that the prevention of malaria was undoubtedly the most important problem with which they were confronted. One of the first steps of the Committee was to get the distinguished malariologist, Colonel S. R. Christophers, C.I.E., I.M.S., as their expert adviser, whose valuable suggestions forecasting the possible sources of danger have been of the greatest help.

The material, obtained from the harbour for filling in, is soft clay and results in fissuring and formation of a very uneven surface during the process of solidification and setting monsoon rainfall on this new land leads to numerous water-collections and form suitable breeding places for mosquitoes.

Large pools are formed at the junctions of the pipes and though containing pure sea-water they have been found on several occasions with anopheline larvæ.

Brackish water pools on the foreshore above the neap tide limit, form very important potential sources of danger and these have also been found guilty on several occasions.

Wells and water cisterns which are a special feature of the City of Bombay abound in the vicinity of the Reclamation works and form permanent breeding places for mosquitoes.

Besides these, features of the works themselves lead to water collections of various types and are constantly changing. Such sources of supply may easily escape notice, unless closely watched, and the most serious may be of a very temporary character.

The following anopheline species have been detected in the Reclamation zone, having been bred out from larvæ and also caught in habitations:—

- (1) *A. Sub-pictus*. (Giles).
- (2) *A. Stephensi*. (Liston).
- (3) *A. Culicifacies*. (Giles).
- (4) *A. Vagus*. (Donitz).

The reclamation breeding pools being to a great extent either salt or brackish water, analyses of different samples where

larvæ were found were made at different times by the Chemical Examiner to the Government of Bombay and it might be of interest to note that all the above-mentioned species breed freely in pure sea-water.

In one instance the sample of water on analysis was found to be as much as three times more concentrated than sea-water.

The actual preventive work carried out in this connection was as follows :—

It soon became apparent that anti-malarial operations of the Reclamation in Colaba, to be effective, should be in close touch with the conditions existing in the immediately adjoining area, for otherwise it would reduce itself to a case of stringent anti-malarial work on one side of a road without knowing what was happening on the other side. The immediately adjoining portion to the Reclamation in Colaba is practically all Military area with a very small portion coming under Municipal jurisdiction. Therefore a meeting was called for by the A. D. M. S. Bombay Brigade in 1923 with the object of forming a close liaison among the three authorities concerned and attaining as far as possible that very important condition in the success of anti-malarial operations namely undivided responsibility. Ever since then the closest co-operation existed in anti-malarial work in Colaba and the following methods were adopted.

The whole area was divided into six more or less equal sections, one section to be dealt with during each day of the week. Work commenced on a Monday morning in a particular section which is finished that day, and so on, each day, until by Saturday evening of that week the whole area is covered. During the course of these inspections a thorough search is made for all likely breeding places which are dealt with as necessary either by using a larvicide or by more permanent measures. Every house in the area is also inspected during the course of the week, and on arrival at a house, the foreman of the gang presents a card in which the tenants are requested to state whether they are troubled by mosquitoes or not. Should the tenants complain of the presence of mosquitoes, a special effort is made to find out the breeding places and they can nearly always be discovered in the immediate surroundings.

All tins, pots, pans or other articles capable of holding water are collected and removed. Waste vegetation is removed and draining away of casual water collections wherever possible is carried out. Tree-holes formed a fertile source of breeding mosquitoes during the monsoon and a few men were detailed to fill up as much as possible all tree holes capable of holding water with a mixture of sand and cement. In all about 1,600 trees in the area were dealt with in this way.

Lectures and demonstrations were given to educate the lay mind to realise that malaria is not caused by some intangible emanation—the miasma—but by the mere mosquito bred out from water collections which could be avoided to a considerable extent by the expenditure of negligible amount of energy and care on the part of every individual.

To gauge with mathematical accuracy an increase or decrease in the number of mosquitoes in any locality is perhaps a difficult task. For the present we have probably to rely on the general consensus of opinion and this, as indicated by the statements of the residents of Colaba area in the weekly cards, has shown freedom from mosquito trouble to a remarkable degree.

Again malarial incidence amongst the British troops resident in Colaba before and after anti-malarial operations were commenced, may be taken as another test of the efficacy of anti-malarial operations and figures kindly given to me by the Officer Commanding British Station Hospital, are as follows:—

During the year 1921 and 1922 before the commencement of anti-malarial work, the ratio of malarial admissions per thousand of strength was 972·46 and 387·14 respectively. During the years 1923 and 1924 after commencing anti-malarial work the ratio of malarial admissions in Colaba dropped down to 152·53 and 238·27 in spite of the fact that the year 1924 was said to be particularly bad year as regards malarial incidence in the rest of the City of Bombay.

To attempt to exterminate mosquitoes from whole continents or even from large rural tracts is a well nigh impossible feat. Even to suppose it possible to exterminate *every* mosquito from towns and cities requires a very high flight of imagination. But it surely falls within the scope of a practicable proposition to aim at *reducing* the numbers of mosquitoes as much as possible. No one considers it possible to drain or otherwise treat every breeding place of mosquitoes in any locality, but even where every such place cannot be dealt with, it will always be possible to deal with a considerable number, and it often happens that the smallest and most easily drained or emptied puddles or pots breed the greatest number of mosquitoes. As a general rule the vast majority of mosquitoes existing in any locality are bred in the immediate surroundings of that locality and if we get rid of these breeding places, we may calculate on at least greatly reducing the insects in that locality.

On the application of these principles we have based our efforts and in the plan of action adopted, we have as far as possible avoided confused councils, divided authority, and delayed execution.

J. E. SANDILANDS.

B. S. CHALAM.

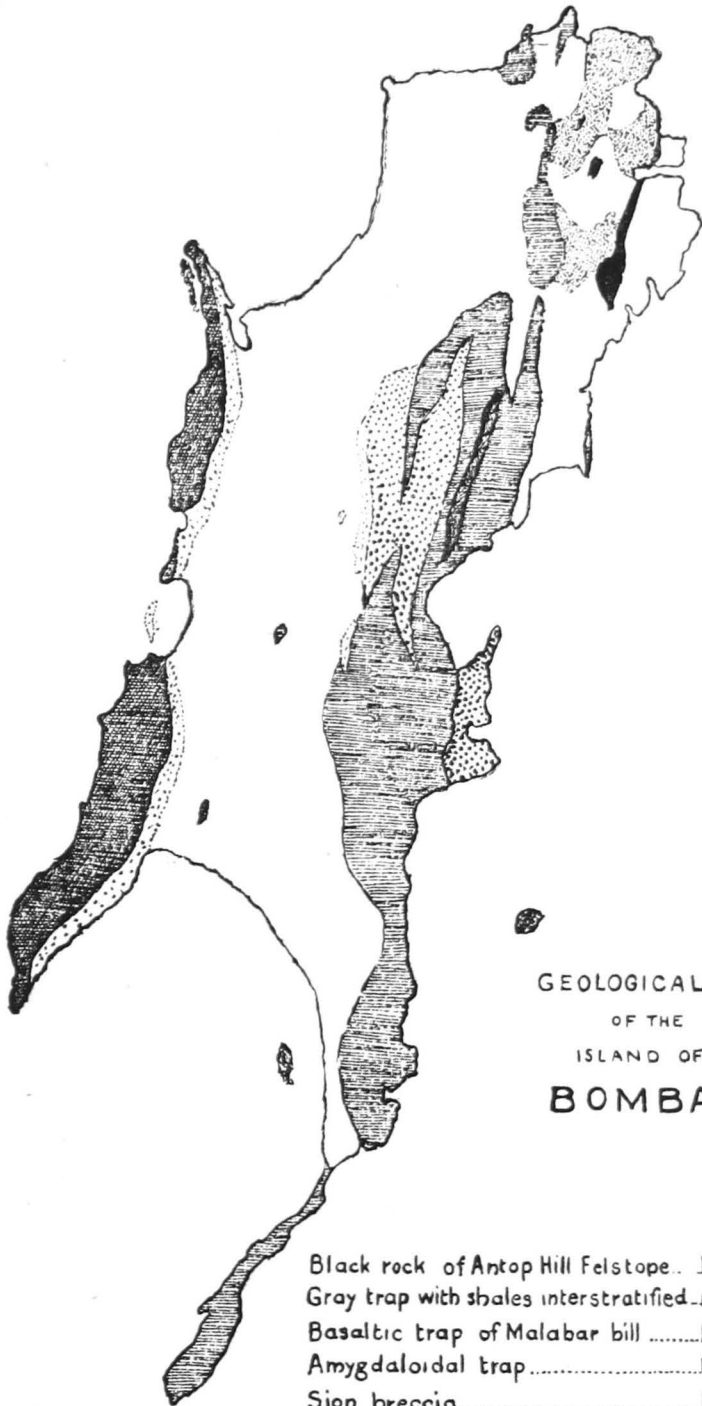
GEOLOGY.

The island of Bombay is separated from the island of Salsette by tidal creeks and alluvial flats whilst the expanse of water forming Bombay harbour lies between it and the mainland to the eastward. The island itself consists mainly of two ridges running north-east by south-west, one from Malabar point to Worli and the other from Colaba point to Sion. These ridges are composed of the Deccan Trap and are separated by alluvial deposits and littoral concrete. The ridges and the flats point to two distinct periods in the formation of the island: first, the period of volcanic activity, for the alluvial deposits are always on the top of the trap, and secondly, the period of denudation and aqueous deposition. (See Map.)







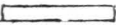
Volcanic Period.—During the first period volcanic activity was not restricted to Bombay and its neighbourhood; but about the end of Cretaceous times, there was a tremendous outburst of volcanic activity which continued up to the Middle Eocene and covered the Indian Peninsula with lavafloes which are known as the Deccan Trap. These bedded basalts extended at one time throughout nearly 10° of latitude and 16° of longitude and over the greater portion of their present area; the most remarkable characteristic is their persistent horizontality. This is conspicuous on the Western Ghats and the whole of the Deccan. The only places where the Trap dips, are the Satpura and Rajpipla hills and along the coast near Bombay. This disturbance, as shown by the later sedimentary beds being involved in the movements, is of a much later date. In the islands of Bombay and Salsette they have an inclination of 5° to 10° to the westward. In the islands of the harbour and in the hills between Thana and Kalyan north of the harbour, the same westwardly slope is visible but further to the eastward towards the Ghat, the traps are horizontal. About 2,000 ft. of horizontal beds are displayed by hills of Matheran and still greater thickness on the flanks of the hills of the Bor Ghat. Taking the average dip of the Traps near the coast to be 5° the whole thickness would be nearly 7,000 ft. a minimum estimate; 10,000 ft. would be nearer the mark. About 1,200 to 1,500 ft. of rocks are exposed in Bombay so that it is evident that the lowest beds seen on the island are higher in the series than the highest flow on the Western Ghats, although some of the higher portions (Mahableshwar) are 4,000 ft. above the sea.*

Volcanic Rocks, Antop Hill Trap.—The lowest of the volcanic lavas, exposed in Bombay, are on the eastern side of the island

* Dr. Buist, Dr. Carter and Mr. Hislop regarded the Bombay Traps to be of the same age as the Lower Traps and the dip in Bombay to be due to a great sheet of intrusive rocks.



GEOLOGICAL MAP
OF THE
ISLAND OF
BOMBAY.

- Black rock of Antop Hill Felstope. 
- Gray trap with shales interstratified. 
- Basaltic trap of Malabar hill 
- Amygdaloidal trap..... 
- Sion breccia..... 
- Fresh-water beds, shales, and flags..... 
- Alluvium and other superficial deposits.. 

at Rowli Hill, Matunga, Antop Hill, Sewri and Cross Island in the harbour. It is described as black jasper or chert, a hard rock which stands out as hills amongst the salt-pans. This rock is probably due to secondary changes in the original earthy composed Traps.

Volcanic Breccia.—Then follow the volcanic breccia which form a continuous track from Carnac Bunder to Sion. These were formed of the accumulation of volcanic ash and block-scoriæ which they contain weather out, remaining in relief. Good examples are seen at Rai Hill at Parel and in the neighbourhood of Sion Fort in Bombay. (Kanheri caves of Salsette are carved out of the same kind of beds.)

The Amygdaloidal Grey Traps.—On the top of these are the Grey Traps which are amygdaloidal in parts stretching from Colaba to Reva Fort. These basalts are interstratified with volcanic tuffs as at Rai Hill, Parel, and with lacustrine deposit at Nowrojee Hill, Matunga, and near the Byculla Club. The chief characteristics of the amygdaloidal basalt are the nodules, chiefly of zeolites, very often covered with glauconite. Sometimes there are good porphyritic crystals of glassy felspar. The lacustrine formations are all shaly beds not unlike the beds under Malabar Hill; and only one, that at Nowrojee Hill, has given Cyprides. Fossils have not been found in the others.

The Bombay Inter-trappeans.—Then come a series of traps which are hidden by the alluvial deposits between the two ridges. The formations that follow are the highest known fresh water beds of the Traps. These are exposed under the basalt of the ridge running right from Malabar point to Worli. The base of these beds is not exposed, but on the east side the thickness is more than 100 ft. in places, and they consist chiefly of earthy shales greyish blue and brownish yellow in colour. Sometimes there are highly bituminous hard pans which are black and carbonaceous and contain layers of a coaly substance and fragments of resin. The greater portion of the formation is evidently made of volcanic detritus, lapilli washed down by water and sand produced by the disintegration of the basalt.

Fauna and Flora.—The Bombay inter-trappeans are fairly fossiliferous. Skeletons of a fresh water tortoise *Hyaraspis Leithi*, and a frog *Rana Pusilla*, considered an *Oxyglossus* by Stolickza, are characteristic of the formation. The carapaces of Cyprides representing the Arthropoda are also abundant, while the Mollusca are rare. Plant remains discovered are badly preserved impressions of seeds, leaves, stems, etc. The fauna represented by the species named is chiefly that of a shallow marsh. Frogs are numerous and their skeletons perfectly showing they probably were deposited near the spot where they died. In some cases there is evidence of the skeleton being dragged along the surface of the shale in which it is embedded and Stolickza suggests,

with great probability, that this was done by the wind. It is not difficult to conceive that due to the lava-flows the drainage of the country was disturbed and valleys and streams were dammed up to produce shallow lakes. The largest revealed in Bombay is the one stretching from Malabar point to Worli, while small ones are at a lower horizon at Nowrojee Hill, Matunga and near Byculla Club.

The highest trap.—The basalt overlying the fresh water bed is the highest lava-flow known to occur in the Trap area and must have been much thicker than it is now. It is 90 feet thick on the eastern side resting on the lacustrine beds, and 51 ft. on the west where it runs out into the sea to an unknown distance. The most compact and stratified flow is at Malabar Hill and sometimes in its scarped portion it presents a columnar structure. The prevailing rock is a blue basalt and is not unlike the basalt which we have described as the Grey Trap of Colaba and Reva.

Period of Aqueous deposits.—After the deposition of Traps began a period of denudation when several thousand feet of basalt were washed away seawards. This denudation was aided by the slow encroachment of the sea. The disturbances in the extra-peninsular area which raised the Himalayas, had their counterpart in the peninsular area, tilting the plateau so that the dry land to the westward was depressed and to the east was elevated. The sea encroached upon the land and combined with the peculiar action of the monsoon produced the cliffs that are known as the Western Ghats. After the carving out of the Konkan plane, the sea retreated and subsequent denudation wiped out traces of marine deposition. But upto a much later time the hills of Bombay Island were separated by estuaries and sufficient time has not elapsed yet, for some of the deposits laid down then, to be washed away. Bombay then consisted of a group of islands and the whole coast had a large number of inlets. A few creeks and Bombay harbour still remain but they are gradually being silted up.

The existence of these old estuaries is revealed by the alluvial flat which stretches from Grant Road to Mahim separating the two Bombay ridges. These alluvial deposits are of yellowish brown and blue clay. The former appears to be the older of the two. Its surface is above the sea level and abounds in large masses of kankar and occasionally yields estuarine shells. The blue clay varies, varying in thickness from a few inches to several feet and contains a large quantity of salt, nodules of kankar and plates of gypsum and is occasionally penetrated by mangrove roots. These estuarine deposits are of the same nature as the mud now laid down in the Bombay backwaters and the harbour.

The most recent formation is the littoral concrete forming the flat surface of the Esplanade and the coast of Mahim. It rests sometimes on the trap but more often on the blue clay and consists of sand and pebbles with marine shells and corals consolidated by a calcareous cement.

Recent oscillations of level.—This calcareous grit points to a recent upheaval of the Esplanade and the coast of Mahim, while the evidence of subsidence is furnished by the excavations at Prince's Dock where a large number of roots and stems have been found in the blue clay, many in the position in which they grew and some 30 ft. below high water mark.

S. N. Moos.

BOTANY.

A. PALÆOBOTANY.

Geologists distinguish 3 periods which led up to the formation of the present island:

1st Period.—Fresh water or lacustrine formation. It belongs to the middle cretaceous or eocene epoch and must have extended over the whole island. The material of which it is composed has been derived from volcanic rocks. The formation contains much wood, fragments of leaves and fruits, and the fossilised remains of plants resembling large Typhaceæ.

2nd Period.—Volcanic effusions. No organic remains.

3rd Period.—Deposits of marine strata. These probably belong in part to the post-pliocene epoch. They are composed chiefly of blue clay and contain fragments of wood, chiefly mangrove-stumps. Below the clay there is a layer of loam and decomposed rock. In this layer a submerged forest has been found of upright stumps of trees of a species still existing in the neighbourhood of the island, the Khair (*Acacia catechu*). There were in all 382 trees, 223 standing erect and 159 prostrate, though still rooted in the soil. The largest trunk was 46 feet long and 4 feet 8 inches in girth. These facts show that, after the volcanic period, the island must have undergone a series of upheavels and depression.

B. PRESENT-DAY BOTANY.

1. *Historical Note.*—The first to take a scientific interest in the vegetation of the island was Garcia d'Orta, the celebrated physician and botanist of Lisbon. He came to India in 1538 with Martin Affonso de Souza, the Admiral of the Indian Seas. He acted as one of the signatories of the Treaty of Bassein and became the owner of Bombay Island on payment of a yearly quit-rent of 1,432½ pagodas (about £85). He wrote "Dialogues

on *Simples and Drugs*," and published them in Goa (*Impresso em Goa per Johannes de Emdem, x Abril de 1553 annas*). An Italian translation appeared in Venice in 1567.

Among the products of the islands Garcia d'Orta mentions in particular the Coconut palm, the Brab tree, the Jack fruit tree, the Jambul, and the Jangoma, of which very few specimens still exist in Bombay. He also mentions that his tenant Simao Toscano sent him mangoes from a tree that yielded twice a year, once about Christmas, and again at the end of May. (Even now there exist in Mazagaon two trees which bear a double crop of mangoes every year.)

In 1828 John Graham, a native of Dumfriesshire, arrived in India. As Deputy Postmaster-General he devoted his moments of leisure to botanical explorations. In 1839 he was able to publish his "Catalogue of Plants growing in Bombay and its vicinity." It is much to be regretted that he died at the early age of 34, on the 28th May 1839, at Khandala. In connection with this catalogue we must not forget to mention the names of Nimmo, Lush, Gibson, Murray and Heddle, with whom Graham was in constant correspondence on the subject of the work and from whom he received much valuable information.

In the same year when Graham left for Bombay, a young French Naturalist, Victor Jacquemont, was sent out to India by the "Museum d' Histoire naturelle." His travels from Calcutta to Delhi, Cashmere and Bombay, are described in his *Journal*, which comprises 3 volumes folio, whilst the 4th volume contains the description of the collections. Jacquemont had a mind to travel from Bombay to the Cape Comorin and then to explore the coast of Coromandel, but he became a victim of his untiring zeal, succumbing in Bombay to the fatigues and the effects of the tropical climate on the 7th December 1832. Jacquemont's tomb in Bombay is now a cenotaph, for his bones were given many years ago to the French Nation.

In 1861, N. A. Dalzell and A. Gibson brought out their "Bombay Flora," which shows a distinct advance in the knowledge of Indian plants since the date of Graham's Catalogue. Many new species had been discovered, and, in addition, a greater degree of precision in the nomenclature and a more accurate determination of species already known had been obtained. No progress had been made in cryptogamic botany, and the authors of the Bombay Flora had to be satisfied with literally transcribing the cryptogamic portion of their book from that of Graham.

There is scarcely a botanical book that attained greater popularity on this side of India than Nairne's "Flowering Plants of Western India," published apparently in 1896. He was followed by T. Cooke, who in his "Flora of the Bombay Presidency," gave a more critical account of the vegetation.

Of the botanists who have collected on Bombay Island we must mention Lisboa, the author of the "Bombay Grasses," Birdwood, Woodrow, etc. A complete collection of Bombay plants is in the Herbarium of St. Xavier's College.

It is strange that, in spite of all the work done, we should not have a flora or at least a list of the plants of Bombay Island.

As to cryptogamic botany very little is known. The Algae have scarcely been touched, a few mosses have been mentioned by Dixon in his various publications, and a number of Fungi have been published by Theissen and Blatter in the Journal of the Bombay Natural History Society and in the *Annales Mycologici* by the former.

During recent years, a survey of fungoid diseases of plants is being carried out by members of the local Department of Agriculture, and the results of their studies are published departmentally.

II. The Flora.—Bombay consisted, until the 18th century, of seven separate islands. No independent flora has developed on them, as is evident from the fact that so far no endemic species have been discovered on Bombay Island. The present vegetation is the product of immigration from the main land, probably *via* Salsette, and of introduction by land as well as by sea. If many species grow in Bombay which have not been noticed in the neighbouring areas of the main land, their occurrence must be attributed to dispersal in consequence of traffic.

Most of the plants which give a characteristic aspect to Bombay Island are not indigenous to it. This is true quite especially with regard to the dicotyledonous trees and shrubs. The greater part of these have been introduced from other parts of India or from foreign countries. Sion wood and some parts of Malabar Hill come nearest our idea of an Indian jungle, but even there we find a number of non-indigenous plants. The herbaceous flora, excepting flowers growing in gardens and escapes from cultivation, can be considered to be indigenous, though many species have reached Bombay only in the course of the last century.

It is not our intention to give lists of plants, but we wish to point out a few characteristic plant-formations to those who are anxious to make a short botanical excursion during their stay in Bombay.

At the northern end of the island between Mahim and Sion there is a narrow belt of mangrove-vegetation. It becomes broader and richer in species on the eastern side of the island, beginning at Sion and running down to Sewree.

The vegetation on the western shore, which is either rocky or sandy, is poor. *Ipomœa biloba* and *Clerodendron inerme* are common and patches of *Avicennia alba* may be seen here and there.

Round Sion Fort a typical Konkan jungle on a small scale may be studied.

Fresh water swamps are numerous between the two railway lines in the northern half of the island.

An extensive cocconut grove stretches along the seashore from Mahim southwards.

Aquatic plants are well represented, especially in some of the larger tanks of Mahim, Worli, Sion, Parel, Lower Parel and Mazagon.

The inhabited part of the island is rich in those types which prevail in densely populated areas and which are usually known as *ruderalia*.

III. Gardens and Avenues :—(1) The Victoria Gardens.—In 1830 a society was formed in Bombay under the denomination of “The Agricultural and Horticultural Society of Western India,” which had for its object the encouragement and improvement of Agriculture throughout the territories of the Bombay Presidency. For this purpose an experimental garden was established at Sewree (the present Cemetery). In 1858 the establishment of an economic museum and pleasure gardens to be entitled the “Victoria Museum and Gardens” was projected by the native inhabitants as a tribute of their loyalty and devotion to Her Majesty the Queen of England on the introduction of her direct authority into India. A site was chosen, and as it was decided that the Agri-Horticultural Society should lay out and maintain the new gardens, the continuance of the Society’s old gardens at Sewree was considered no longer necessary and it was therefore resolved that the latter should be transferred to the new site. Not quite ten years later the Victoria Gardens were transferred to the Municipality. Since then a great number of plants have been introduced into the Gardens and from there into private gardens. The “List of plants for sale at the Victoria Gardens” (to be had at the Superintendent’s Office, Victoria Gardens), though being far from complete, gives a fair idea of the novelties introduced. It is to be regretted that so far no steps have been taken to develop the Gardens into a scientific establishment. It is, after all, not so difficult, to combine the features of a scientific institution for research and education with those of a pleasure garden.

(2) Other Municipal Gardens.—We mention only the “Hanging Gardens” of Malabar Hill, the gardens on the southern and eastern slopes of Malabar Hill, laid out lately under the able direction of Mr. A. M. DeCruz, the Charni Road Gardens and the Elphinstone Circle Gardens.

(3) Private Gardens.—Bombay is full of gardens, some of them very old, but neglected and left to themselves. There are some fine gardens in almost every part of the town. The

most beautiful ones are on Malabar Hill, where the Ladies' Gymkhana Garden and some others are well worth a visit. We must not forget to mention the garden of the Byculla Club. If a visitor to our island is anxious to obtain detailed information regarding horticulture in Bombay we advise him to apply to Mr. A. M. DeCruz. There is probably nobody in Bombay who has taken a keener interest in introducing new plants than this enthusiastic horticulturist.

(4) Avenues.—The more common avenue trees are: *Poinciana regia*, *Pongamia glabra*, several species of *Cassia*, *Pithecolobium saman*, *Pithecolobium dulce*, *Peltophorum ferrugineum*, *Adenantha pavonina*, *Tamarindus indica*, *Saraca indica*, *Thespesia populnea*, *Kleinhovia hospita*, *Millingtonia hortensis*, *Azadirachta indica*, *Michelia champaca*, *Terminalia catappa*, *Polyalthia longifolia*, *Calophyllum inophyllum*, *Chrysophyllum cainito*, *Casuarina equisetifolia*, *Ficus bengalensis*, *Ficus religiosa*, *Ficus retusa*, *Ficus mysorensis*, *Caryota urens*, *Oreodoxa regia*, etc.

IV. *Botanical Collections*:—There are only two herbaria in Bombay: one at the Bombay Natural History Society's rooms (6 Apollo Street, Fort), and the other at St. Xavier's College (Cruickshank Road, Fort). The latter contains an almost complete collection of the plants of the Bombay Presidency with numerous specimens from different parts of India.

E. BLATTER.

SOME INTERESTING ECONOMIC PLANTS IN THE VICTORIA GARDENS.

Acacia Catechu, var *Sundra Prain*. (Leguminosæ)—Catechu or Cutch tree. An Indian tree, the heartwood of which furnishes *Catechu* or *Cutch*, a powerfully astringent substance used medicinally and in tanning.

Achras Sapota, *Linn.* (Sapotaceæ)—Naseberry or Sapodilla. A tropical American tree bearing sweet fruits with a brown rind, resembling in size and appearance a potato, which though not well known to Europeans are esteemed by all classes of the Indian people as well as in the West Indies. The fruit is so much in demand in Bombay that it is now commonly cultivated in almost all gardens and is the most paying fruit tree at present realizing as much as Rs. 30 or more for each tree's fruit crop per year.

Adansonia digitata, *Linn.* (Malvaceæ)—Baobab or Monkey-bread tree. A remarkable looking Tropical African tree noted for the great age to which it lives—said to be up to about 5,000 years, and also for the thickness of its trunk,

attaining about 30 inches in diameter, which has a peculiar inflated appearance. The fruit is very large, woody, oval, with a rind similar in texture and colour to that of the tamarind pod, containing an agreeable acid pulp which is used for making a cooling sherbet in the hot weather.

Ægle Marmelos, Corr. (Rutaceæ)—Baeltree or Bengal Quince. A small spinous tree, native of India and sacred to the God Shiva. It bears hard, woody, globular fruits with a pale green shell varying in size from a cricket ball to a large melon. The stiff pulp of the fruit containing masses of clear mucilage is a reputed specific for dysentery taken in the form of a sherbet or conserve.

Aeschynomene aspera, Linn. (Leguminosæ)—Sola plant. A marsh shrub of India not common in the Bombay Presidency, but very common in Bengal, the remarkable light and spongy pith-like stems of which furnish the *sola* of India used for making sola hats and floats for fishermen, etc.

Artocarpus incisa, Linn. (Urticaceæ)—Bread Fruit tree. A relative of the well known Jack Fruit tree, a very handsome tropical tree, native of the Pacific Islands, with very large, polished, dark green, deeply cut leaves, bearing at the ends of branches large round or oval fruits of the size of a melon with a solid mass of fleshy pulp which sliced and roasted or fried forms an excellent vegetable, and roasted and ground into flour forms the principal article of diet of the natives of the South Sea Islands.

Bamboos.—Among the bamboos in the Gardens the following are worth noting :—

Bambusa vulgaris, var *striata*, Gamble (Gramineæ)—A very ornamental variety of bamboo, native of China and Japan, probably the result of cultivation. The stems are bright golden yellow marked with vertical green lines.

Dendrocalamus giganteus, Munro (Gramineæ)—Giant Bamboo. This is, perhaps, the largest bamboo known, native of Burma and Malaya. A magnificent species attaining a height of over 100 feet with stems up to 8 inches or more in diameter.

Melocanna bambusoides, Trin.—(Gramineæ) A fine thin straight unbranched bamboo, bearing seeds as large as olives quite unlike the seeds of other bamboos.

Bassia latifolia, Roxb. (Sapotaceæ)—Mohva tree. A very useful deciduous tree of India. The fleshy flowers are largely eaten, and yield by distillation a spirit—the *Mohva* liquor—commonly used by the people of this country, yielding a large revenue to Government. The oil extracted from the kernel of the fruit is edible and is also used for soap making.

Bixa Orellana, Linn. (Bixineae)—Arnatto. A quick growing large shrub of Tropical America and cultivated throughout India, bearing at the ends of branches clusters of dark crimson prickly capsular fruits. The bright crimson covering of the seeds yields the *Arnatto dye* used for dyeing silk, etc., and also for colouring butter, cheese, etc., by dairymen.

Broussonetia papyrifera, Vent. (Urticaceae)—Paper Mulberry or Tapa cloth. A small tree growing wild in China, Japan and also in many of the islands of the Pacific Ocean where the natives manufacture a large part of their clothing from its bark. The Japanese cultivate this plant much in the same way as Osiers are grown elsewhere, using young shoots for the manufacture of paper. From the bark of the tree the Burmese make their curious papier-mache school slates (*Para baik*). The *Tapa-cloth* of the South Sea Island and the Karen's *Mulberry paper-cloth* are also made from it.

Butea frondosa, Konig. (Leguminosae)—Bengal Kino or Palas. A small deciduous tree indigenous to the forests of the dry regions of India, a very conspicuous and handsome object when in blossom with its profusion of orange or salmon coloured flowers which yield a brilliant but fleeting dye. The bark yields an astringent resin used for tanning and medicinal purposes.

Cæsalpinia coriaria, Willd. (Leguminosae)—American Sumach or Divi-divi tree. A small spreading tree of Central America and West Indies, the small twisted pods of which form the *Divi-divi* or *Libi-dibi* highly valued in Europe as a source of tannin.

Cananga odorata, Hook. (Anonaceae)—Ilang-Ilang. A quick growing tree, native of the Philippine, Java, etc., with large greenish yellow strongly scented flowers which yields on distillation, the popular scent *Ilang-Ilang* or *Ylang Ylang*.

Cassia alata, Linn. (Leguminosae)—A large spreading shrub introduced in this Presidency perhaps from the West Indies, extremely handsome with its bold foliage and terminal cone-shaped racemes of closely packed large deep yellow flowers. The leaves have a high repute as a local application in skin diseases specially ringworm.

Cassia fistula, Linn. (Leguminosae)—Indian Laburnum or Pudding-pipe tree. A small upright deciduous tree common throughout the Presidency in dry regions and well known to Europeans as the Indian Laburnum, very beautiful in flower with its numerous, long pendulous racemes of bright yellow flowers resembling the Laburnum. The pendulous, cylindrical, shining black pods from 1 to 2 feet in length, contain a blackish brown, viscid, sweetish pulp which is used as an excellent and safe purgative under the name of *Garmal*.

Castanospermum australe, A. Cunn. (Leguminosae)—Moreton Bay Chestnut. A moderate sized handsome tree, native of

Queensland, bearing large peculiar fruits, the seeds of which are similar in appearance to, and when roasted resemble in flavour the chestnut though much inferior to it.

Chrysophyllum Cainito, Linn. (Sapotaceæ)—Star-apple. A very ornamental West-Indian tree with a graceful habit. The large laurel-like leaves are very striking and ornamental especially when waving in a breeze, by the contrast of the glossy dark green of the upper surface and the golden or copper coloured underside. The round smooth fruits from 2 to 3 inches in diameter contain a white jelly-like substance surrounding the seeds which when ripe is somewhat agreeable in taste.

Cinnamomum camphora, Nees. (Laurineæ)—Camphor tree. A moderate sized evergreen tree, native of Formosa, China and Japan. *Camphor* is obtained by dry distillation of the wood, leaves and root of this tree.

Cinnamomum zeylanicum, Blume, Bijdr. (Laurineæ)—Cinnamon tree. A medium sized evergreen tree, native of Ceylon and Java. The bark of the young shoots slit longitudinally and removed form the *cinnamon* of commerce. The leaves are aromatic giving oil of cinnamon.

Coffea arabica, Linn. (Rubiaceæ)—Coffee plant. A large woody shrub of Tropical Africa, the ripe berries of which furnish *coffee*.

Coffea liberica, Bull et Hiern. (Rubiaceæ)—Liberian Coffee plant. A native of West Tropical Africa, is a robuster plant thriving at lower elevations and bears larger beans though of inferior flavour than the Arabian Coffee plant.

Crescentia Cujete, Linn. (Bignoniaceæ)—Calabash tree. A small tree, native of the West Indies and Tropical America, bearing flowers on the stem and older branches which are in colour a mixture of green, purple, red and yellow. The fruit much resembles a pumelo in appearance having a very hard rind, which, after the removal of pulp which is said to possess medicinal properties, is used in South America as a domestic vessel.

Croton Tiglium, Linn. (Euphorbiaceæ)—Croton-oil plant. A large shrub native of India and China, and naturalized in South Konkan, from the seeds of which is obtained *Croton oil* (*Jamalgota*) which is a drastic purgative.

Cyperus papyrus, Linn. (Cyperaceæ)—Egyptian Papyrus. An ornamental large Egyptian sedge growing in swamps and on water margins, is supposed to be the bulrush of which the ark of the child Moses was made. The ancients made paper from the pith of its stems by cutting them into thin slices, laid side by side and heavily pressed after sprinkling them with a gummy water.

Erythroxylon Coca, Lam. (Lineæ)—Coca or Cocaine plant. A small handsome shrub native of Andes and Peru with leaves of a pleasant light green colour, small white flowers and handsome red berries. The leaves are used by the native Indians with a little unslaked lime as a masticatory which acts as a gentle stimulant enabling them to do hard work on little food. The active principle contained in the leaves is *Cocaine* the well known anæsthetic for superficial surgical operations.

Eugenia caryophyllata, Thunb. (Myrtaceæ)—Clove tree. A small conical tree, native of the Moluccas and cultivated in Southern India. The dried unexpanded flower buds of this tree form the *cloves* of commerce.

Eugenia Jambos, Linn. (Myrtaceæ)—Rose-apple. A moderate sized handsome tree, native of India and Malaya bearing fragrant pinkish white fruits of the size of a small apple of a sweetish-acid taste.

Eugenia javanica, Linn. (Myrtaceæ)—Wax Jamboo or Jamrul. A small Malayan tree producing clusters of pretty, shining, pinkish white, waxy looking fruits.

Eugenia malaccensis, Linn. (Myrtaceæ)—Malay-apple or Malacca Jamb. A very handsome tree of the Malay Islands with large, leathery, oval leaves, producing a great profusion of beautiful crimson flowers followed by pear-shaped bright red edible fruits.

Garcinia indica, Chois. (Guttiferæ)—Kokam-butter tree. A small Indian tree, bearing globose purplish fruits resembling the Mangosteen, having an agreeable acid flavour, used in making curries, etc. From the seeds is obtained a solid oil known as "*Kokam-butter*" used in India for healing chaps and abrasions.

Garcinia xanthochymus, Hook, f., (Guttiferæ)—A symmetrical cone-shaped bushy tree, native of South India and Malaya, producing handsome yellow fruits of the size of a small orange the juicy pulp of which is of a strongly acid but refreshing taste and also yields an indifferent gamboge.

Guaiacum officinale, Linn. (Zygophylleæ)—Lignum Vitæ tree. A very small slow growing West Indian tree, one of the very best large shrubs in the gardens both on account of its dark green glossy foliage and very beautiful cuplike flowers dark blue at first, turning pale afterwards. This plant yields the *Lignum vitæ*, a greenish brown, hard heavy wood extensively used by turners, and also the fragrant gum *guacium* used medicinally.

Hæmatoxylon campechianum, Linn. (Leguminosæ)—Logwood tree. A small slow growing Central American tree bearing thick spikes of fragrant yellow flowers. The heartwood yields the *logwood dye* valuable in the manufacture of woollen and silk goods, one of the few vegetable dyes which retain their position

in the market in these days of aniline colours. This dye is also said to be a large constituent with brandy of cheap port wine. The bark of the tree is powerfully astringent.

Hippomane Mancinella, Linn. (Euphorbiaceæ)—Manchineel tree. A West Indian tree containing an acrid poisonous milk which the natives use for poisoning their arrows. The milky juice produces temporary or total blindness by the slightest touch of it to the eyes or even if one sits over a fire made from its wood.

Ilex paraguayensis, St. Hilaire. (Ilicineæ).—Mate or Paraguay tea. A small bushy evergreen tree of Paraguay with large shining green leaves similar to those of the tea plant, extensively used in South America for the same purpose as tea is used here, containing the same active principle as tea but without the injurious tannic acid. An infusion made with boiling water of the leaves dried or roasted over a wood fire has an agreeable, aromatic odour and slightly bitter taste, and is greatly stimulating and refreshing especially after fatiguing journeys.

Macadamia ternifolia, F. M. V. (Proteaceæ)—Queensland Nut tree. An ornamental small evergreen tree from Eastern Australia bearing hard nuts of the size of marbles, containing a white firm kernel as crisp as that of the hazel nut with a rich agreeable flavour resembling that of the filbert.

Meleleuca leucadendron, Linn. (Myrtaceæ)—Cajuput-oil tree. A large tree of the Malay Islands and Australia with the trunk covered with a thick, light, spongy, brown and white bark, peeling off in layers. The leaves of the variety minor yield the *Cajuput oil* which has a considerable reputation as a rubifacient and counter-irritant in muscular rheumatism. This tree is considered suitable for planting in malarious swamps in tropical countries, especially at low elevations where many of the Eucalypti do not thrive.

Manihot utilissima, Pohl. (Euphorbiaceæ)—Cassava or Tapioca plant. A tropical South American herbaceous perennial large shrub the long tubers of which yield a valuable starchy food called *Tapioca*, after their poisonous juice containing prussic acid is destroyed by pressing and washing the grated root and subsequently heating it.

Mimusops hexandra, Roxb. (Sapotaceæ)—Rayan or Khirni. A large evergreen tree common in the Deccan Peninsula. The ripe yellow berry though very astringent is eatable and sold in the Bombay Market as *Amdavadi Meva*.

Murraya exotica, Linn. (Rutaceæ)—China Box or Satin Wood plant. A very handsome, evergreen bushy large shrub with glossy dark green foliage resembling a box-tree and bearing a profusion of deliciously scented orange-blossom like white flowers. The wood resembles box-wood and is used for wood engraving.

Myristica fragrans, *Houtt.* (Myristicaceæ)—Nutmeg tree. A moderate sized tree of Moluccas bearing pale amber fruits resembling an apricot in appearance which when ripe slit open and disclose the hard brown seed—the *nutmeg* of commerce surrounded by a network of scarlet aril which is the spice known as *Mace*.

Myroxylon Toluiferum, *H. B. K.* (Leguminosæ)—Tolu Balsam tree. A South American evergreen tree with handsome dark green foliage. An incision into the bark of the tree yields the drug known as *Tolu Balsam* similar to the Balsam of Peru possessing mild stimulant and expectorant properties.

Palms.—Among the several kinds of palms, economical and ornamental, in the Gardens, the following may be noted :—

Arenga saccharifera, *Labill.* (Palmeæ)—Sugar Palm or Gomut Palm. A beautiful palm, native of Eastern Archipelago, with large, dark green, shining leaves which take a graceful plume-like curve towards the summit. It is one of the sources of Palm sugar or *Jaggery* obtained in the Malayan countries in the same way as is got from the Palmyra in India. Sago is obtained from its stem and the palm yields a black horse hair like fibre called *Ejoo* or *Gomuti* by the Malayas, used for coarse cordage and brush making,

Attalea Cohune (Palmeæ)—Cohune Palm. A Brazilian palm with stiff erect leaves like those of the Coconut, the hard bony fruits of which are used for turning into fancy articles.

Corypha umbraculifera, *Linn.* (Palmeæ).—Talipot or Fan palm. One of the largest, most stately and beautiful member of the palm family, native of South India and Ceylon, with gigantic orbicular leaves from 8 to 16 feet in diameter, used for making mats, fans, umbrellas, etc., and for writing, forming the materials on which some of the oldest Sanskrit manuscripts were written. This palm like some other palms flowers once in from 20 to 40 years and then dies down, but is a very striking object when in flower with its huge plume-like inflorescence at its summit, which is, perhaps, the largest of all plants. The hard ivory-like seeds called *Bajurbet* are used in turnery for making buttons, beads, etc.

Elæis Guineensis, *Jacq.* (Palmeæ)—A Tropical West African palm of great economic importance, the fruits supplying the natives with a favourite article of food, the stem yielding an intoxicating drink, and the fruit kernels a valuable commercial oil.

Pandanus utilis, *Bory.* (Pandanaceæ)—A species of the screw-pine, native of Madagascar and a common wild plant in Mauritius where it is called *Vacua* or *Bacua* and its leaves used for manufacturing sacks for exporting sugar.

Phyllanthus distichus, *Muell. Arg.* (Euphorbiaceæ)—Star-gooseberry. A small tree, native of India and Malaya with

graceful feathery leaves and bearing pale green round and ribbed acid fruits used for pickling and preserves.

Phyllanthus Emblica, Linn. (Euphorbiaceæ)—Emblie Myrobalan or Amla. A medium sized deciduous Indian tree with graceful feathery foliage, bearing smooth, round, fleshy, pale yellow, astringent fruits of the size of marbles which conserved in sugar are much esteemed as a cooling laxative and useful in dyspepsia.

Quassia amara, Linn. (Simarubaceæ)—Surinam Quassia tree. A small handsome tree attaining only a spare shrubby growth here, bearing curious, large, dark green leaves with fine articulated leaflets having red midribs and winged petioles, and terminal panicles of charming coral red flowers about an inch long. The whole plant contains a bitter principle and the wood furnishes the well known *Quassia chips* used for medicinal purposes as a tonic and also as an insecticide by gardeners.

Rubber Trees—The best of all rubber trees Para Rubber (*Hevea braziliensis*, Euporbiaceæ)—has failed to grow in the Gardens, but specimens of the following kinds can be seen:—

Castilloa elastica, Cerv. (Urticaceæ)—Central American Rubber tree. A quick growing tall tree of Central America producing rubber in quality next to Ceara Rubber. It does not thrive well in the Gardens.

Ficus elastica, Roxb. (Urticaceæ)—India Rubber tree. A very large spreading, handsome, Indian tree, with oval, leathery, shining leaves, yielding good rubber but taking comparatively long to attain a tapping age. Like its relatives the Bunyan, Peepal, etc., it thrives very well here.

Manihot Glazioui, Muell. (Euphorbiaceæ)—Ceara Rubber tree. A small quick growing tree of South America thriving at medium elevation and in drier climate than does the Para Rubber tree, and yielding a satisfactory return of rubber second in quality only to Para Rubber. It grows well in the gardens.

Sapindus laurifolius, Vahl. (Sapindaceæ)—Soapnut tree or Soapberry. A tree indigenous on the Ghats of N. Kanara and cultivated throughout India. The fleshy berries are commonly used as a soap for cleaning clothes.

Silk-Cotton Trees.—The following three silk-cotton trees are represented in the Gardens:—

Bombax malabaricum, D. C. (Malvaceæ)—Sáwar or Silk-Cotton tree. A large deciduous tree with wide spreading branches found throughout the Bombay Presidency and a very conspicuous object in the cold season with its numerous large, bright red, cup-like flowers. The numerous seeds contained in its large pods are enveloped in a downy heap of white silky hair which is known as *Simul* and forms an excellent material for filling beds, cushions and pillows.

Cochlospermum Gossypium, D. C. (Bixineæ)—Guneri or Yellow Silk-Cotton tree. A small deciduous tree, native of the dry hills and forests of Central India and very rare in Bombay, where it does not seem to thrive well. This tree is even handsomer than the Bombax, bearing large bright yellow flowers—4 to 5 inches in diameter—in a few flowered terminal panicles. The seeds contained in the five lobed capsular fruit are covered with an abundance of pure white floss like the Sáwar.

Eriodendron anfractuosum, D. C. (Malvaceæ)—Safed Sáwar or White Silk-Cotton tree. A tall deciduous tree with a straight tapering trunk and whorls of horizontal branches growing in tiers one above another, is also rare in this Presidency being found wild only in Khandesh. The seeds of this tree are also covered with copious silky floss used for the same purpose as that of Bombax but of greater commercial value and is imported into Europe under the name of *Kapok*.

Swietenia Mahagoni, L. (Meliaceæ)—Mahogany tree. A large spreading valuable timber tree of South America with handsome foliage, and famous for its wood used for furniture making. It thrives well here.

Theobroma Cacao, Linn. (Sterculiaceæ)—Cacao, Cocoa or Chocolate tree. A woody shrub of South America, bearing large warty or furrowed, pointed, red pods on the stem and branches, containing a large number of closely packed large seeds which when roasted and ground down to a paste with sugar, starch, vanilla, etc., form the *cocoa* and *chocolate* of commerce.

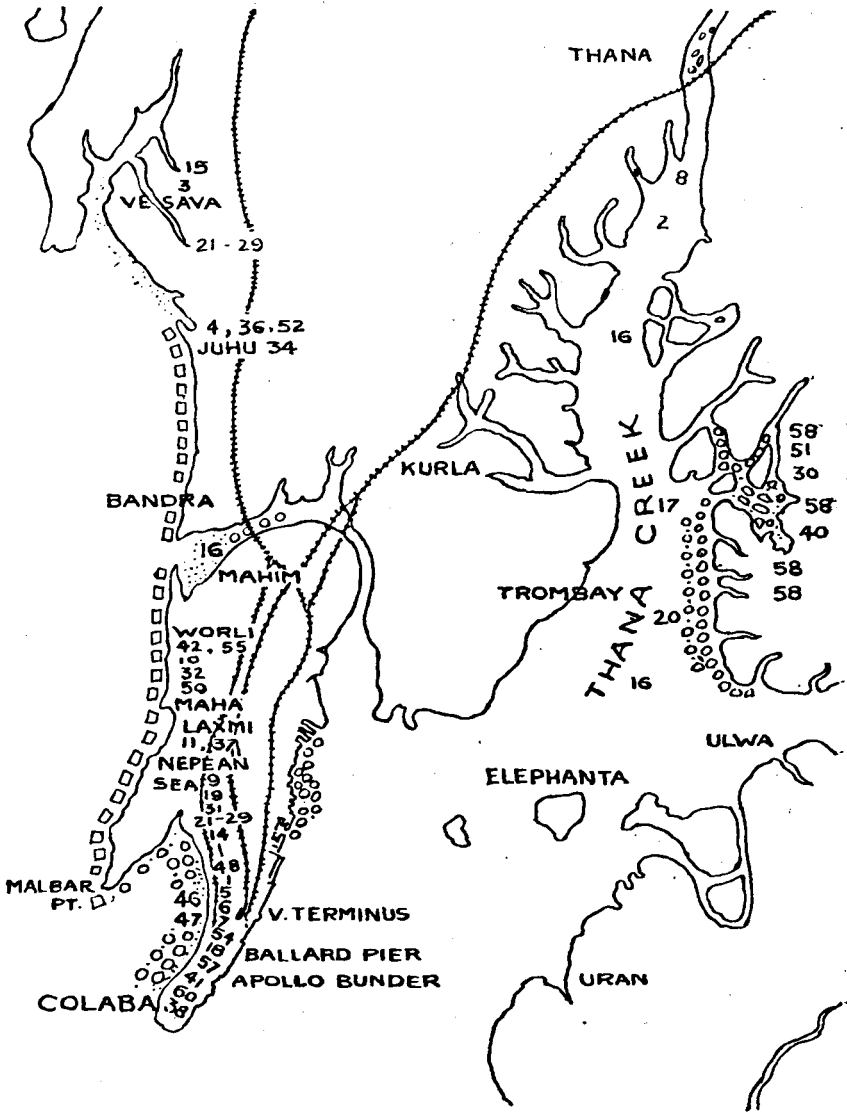
WILD ANIMALS IN BOMBAY.

BOMBAY on account of the dense population of these days is hardly a suitable place for harbouring wild animals. Still venomous snakes are met with even now in different parts of the island. Cobras and Kraits are found practically all over Bombay, while the Russell's viper appears to be a common denizen of the northern part of the island.

According to Hector Macneill there was abundant wild big game in the immediate neighbourhood, towards the end of the eighteenth century and "the Governor and most of the gentlemen of Bombay used to go annually on a party of pleasure to Salsette to hunt wild boar and royal tiger both of which were found there in great plenty." In 1806 two tigers were seen near General Macpherson's bungalow at Kurla, while only a few days previously two persons were carried off from a village just a little further north, presumably by the same animals. Coming to the Island of Bombay itself we find the following recorded on the 9th February 1822 :—"A tiger on Malabar Hill came down, quenched its thirst at Gowalia Tank and ran off

over the hill between the Hermitage and Prospect Lodge. Prints of its feet were distinctly visible this morning," Bishop Heber speaks in 1829 of "the occasional occurrence of hyaenas only in Bombay," but the "Bombay Courier" of the same year records the sudden appearance of a tiger at Mazagon. "The animal had apparently swam across the harbour and landed near the ruined Mazagon fort, and thence was driven to the compound of Mr. Henshaw's bungalow where he was eventually shot by the guard of the Dockyard and certain Arabs." In 1830 a large hyaena was seen prowling on the western side of the Malabar Hill and the chase after it was described in the daily papers, "as good sport of a Mazagon tiger." On the 3rd of March 1858 "some officers of the P. & O. steamer *Aden* observed a tiger swimming from mainland to Mazagon. A boat was lowered and the crew armed with muskets. When they came up to it the brute was boarding a buffalow, and was being kept off by the lascars by hand pikes. It was shot through the head by six balls." The same year in the month of May a young Portuguese shot a tiger at Mahim. On February 15th 1859 a panther was seen "prowling about the nooks of Kalbadevi Road" but disappeared; it was afterwards shot by Mr. Forjett, the Commissioner of Police, "within a few hundred yards of the fashionable drive on the Esplanade, on the beach of Back Bay near Sonapur." On the 5th of December 1860 a hyaena was shot "while devouring a bullock not far from the Byculla Club House." In 1861 hyaenas were quite common at night prowling about the Byculla flats. In 1863 a tiger mauled a Parsi cart-owner at Mahim and did other damage; it was subsequently shot near the Railway station. Recently in December 1907, Mr. Mullen of the Bombay Port Trust shot a tiger near the Sandow Castle at Pir-pau.

Jackals were very common in Bombay in olden days, and were found not only on Malabar and Cumballa Hills, and in the sparsely inhabited northern districts of the island, but the old city walls also used to afford them shelter. Dr. Buist "saw jackals several times in the garden of the Colaba Observatory" in 1844 when he was in charge of the institution; while Mr. Charles Chambers, F.R.S., found one in his bed room in the Observatory about the year 1878. About the same time a jackal was killed in the New High Court Buildings. In the cold season of 1913-14 Major Kunhardt, I.M.S., saw a jackal being chased by pariah dogs between Churney Road Railway station and the Kennedy Sea Face. In the year 1904 a jackal was caught in the St. Xavier's College compound and the Rev. Fr. Blatter informs me that on the 15th November 1918, *i.e.*, fourteen years later, another jackal was captured in the same compound.



000 MUD
 SAND
 000 ROCKS
 0-0-0 SANDY MUD

DIGRAMATIC MAP
 SHOWING
 THE DISTRIBUTION OF INVERTEBRATE ANIMALS
 ALONG THE COAST OF BOMBAY
 1923 - 1924.

* A NOTE ON MARINE ANIMALS OF BOMBAY SEAS.

The following is a list of animals of the Arabian sea round about Bombay with notes on their ecology :—

GROUND.—The nature of the ground on which the sea rolls plays a very important part in determining its fauna. It has been shown that mud, fine sand, shingle, coralline detritus, etc., has each its own characteristic facies of the marine fauna.

(i) *Coast.*—The coast of Bombay is not continuous but it is broken everywhere into long and deep brackish estuaries formed by huge torrents issuing from the Western Ghats and flowing into the sea. The nature of the coast whether rocky, muddy, sandy, shingly or otherwise depends on the geological formations of the locality exposed or the nature of the detritus washed down by the streams. The fauna represented on the different parts of the coast is quite characteristic of each such geological formation exposed at the place.

(ii) *Sea-bottom.*—The floor of the Arabian sea between 18° N and 20° N Lat. within which the Isles of Bombay and Salsette lie, is gradually sloping down for nearly 120 miles due west to form the Continental Shelf or Plateau. The depth of water on this shelf varies from 10 fathoms or less to 100 fathoms. The slope, however, becomes too precipitous after that distance which is also the 100 fathom line.

The sea bottom of this area consists of dark grey clayey mud upto the edge or sometimes beyond the continental shelf. This layer of mud which is very deep at some places is the accumulated sediment of the land-derived material which has been washed down from the land surface of the Western Ghats by the rains and carried away by streams for countless ages. Here and there among the almost universal expanse of mud are to be found patches of sand, broken shells, etc. Patches of coral reefs are generally at or beyond the 40 fathom line.

ANIMALS.

(i) *Fish.*—The local fishermen confine themselves to the estuary and coastal fishing mostly during the monsoons and even in the fair weather, though some of them venture out for fishing on the open sea not very far off from the coast.

In the year 1921-22 an experiment on deep sea fisheries was however tried for the first time. It was intended in the beginning purely for commercial purposes rather than for research. Though the experiment failed at the time, yet the information gathered and the experience acquired are of great value and it is hoped that they will be utilised in future research work on Bombay fisheries.

The following is a list of edible fish from the deep as well as from the estuarine waters :—

1. Ghol (*Sciaena diacanthus*). Its swim-bladder is used for Isinglass preparations.
2. Saranga, (*Stromateus cinereus*). This fish is considered a delicacy. White Pomphret.
3. Ravas (*Polynemus indicus* and other species).
4. Karel (*Pristipoma maculatum*).
5. Khajura (*Lates calcarifer*).
6. Wam (*Muraenesox talabonoides*). Bombay Eel.
7. Tambusa (*Lutjanus johnii*).
8. Shingala (*Arius Sp.*)
9. Dori (*Sciaenoides brunneus*).
10. Chand (*Drepane punctata*).
11. Wagli (*Trygon wagla*). Skates and Rays.
12. Palu (*Chrysophrys berda*).
13. Lal Palu (*Pagrus spinifer*).
14. Surmai (*Cybius lineolatus*).
15. Bhakas (*Psettodes erumei*). Flat fishes.
16. Mushi (*Carcharias Sp.*) Sharks.
17. Kaneri (*Zygaena Sp.*)
18. Kandere (*Pristis Sp.*)
19. Lanj (*Rhynobatus Sp.*)
20. Datridhume (*Otolithus ruber*).
21. Ravas (*Polynemus sextarius*). Indian Salmon.
22. Saundala (*Lactarius delicatulus*).
23. Lalbi (*Caranx malabaricus*).
24. Bangda (*Scomber microlepidotus*).
25. Bangda (*Synagris Sp.*)
26. Nivta (*Boleophthalmus Sp.*) Mud Skipper.
27. Chorbombil (*Saurida tumbil*).
28. Bombil (*Harpodon nehereus*). Bombay Duck.
29. Kanta (*Pellona Sp.*). Herring.

(ii) *Invertebrates*.—The following is a list of some of the invertebrate animals in the area between the tide marks as well as in the littoral zone of the sea. These animals have not yet been completely identified :—

Protozoa Few species of (1) Foraminifera.
(2) Noctiluca.

- Coelenterata. (3) Halocordyle, (4) Campanularia,
(5) Sertularia, (6) Physalia,
(7) Valella, (8) Various kinds of
Medusae (9) Actinia, (10) Bunodes,
(11) Zoanthus, (12) Cerianthus
(13) Edwardsia, (14) Pennatula,
(15) Cavernularia, (16) Pleurobrachia
(17) Beroe, etc., etc.
- Platyhelminthes. (18) Various polyclads.
- Nemertines. (19) Lineus and other genera.
- Chaetognatha. (20) Sagitta.
- Annelida. (21) Nereis, (22) Polynoe, (23) He-
sionus, (24) Glycera, (25) Eunice,
(26) Amphitrites, (27) Sabellids,
(28) Spirorbis, (29) Serpulids, (30)
Pectinaria, etc., etc.
- Gephyrea. (31) Thalassema, (32) Sipunculoid-
(Dendrostoma, Sipunculus).
- Polyzoa. (33) Flustra, (34) Crisia, etc., etc.
- Arthropodes. (35) Small Crustaceans. (36) Eupa-
gurus, (37) Scylla, (38) Palinurus,
(39) Squilla, (40) Pinnoteris, (41)
Balanus, (42) Amphipods (43) Iso-
pods, (44) Argulus, (45) Cymothea,
etc.
- Echinoderms. (46) Asterias, (47) Asterina, (48)
Astropecten, (49) Holothuria,
(50) Cucumaria, (51) Echinus,
(52) Antedon with Myzostomum,
etc., etc.
- Mollusca. (53) Turbinella, (54) Aplysia,
(55) Patella, (56) Cyprina, (57)
Chiton, (58) Placuna (Pearl shell),
(59) Teredo, (60) Ostrea different
species), (61) Sepia, (62) Loligo,
etc., etc.
- Brachiopoda. (63) Lingula.
- Tunicates. (64) Simple and compound forms.

The Bombay shore and deep sea are still a virgin field for research in Marine Biology. The study of bionomics of the animals of the above groups has recently been started at the Royal Institute of Science and it is hoped that before long it will be possible to offer facilities at the above Institute, for research workers from other parts of India.

* THE HAFFKINE INSTITUTE.

This is housed in the Old Government House at Parel. The laboratory was originally started by Mr. Haffkine, the discoverer of anti-plague vaccine, on the 8th October 1896, a fortnight after plague had been officially declared to exist in Bombay. At first it was situated in a room of the Petit Laboratory at the Jamsetjee Jeejeebhoy Hospital and was known as the Plague Research Laboratory. Very soon the Laboratory was transferred to a bungalow on Malabar Hill, then to H. H. the Aga Khan's bungalow at Mazagaon and finally, in 1899, to its present commodious quarters. The original name was changed with the subsequent growth of the laboratory to the Bombay Bacteriological Laboratory and recently it has been renamed the Haffkine Institute to commemorate the name of one whose labours have saved the lives of many thousands in India and elsewhere.

Anti-plague vaccine is prepared here and it was in this laboratory that the Plague Research Commission proved that the transmission of plague takes place through the agency of rat fleas and accumulated the mass of epidemiological and experimental data on which schemes for the prevention of plague are based.

The south wing of the laboratory was rebuilt and the whole building was refitted during the Directorship of Lt.-Colonel Glen Liston, C.I.E. In 1922 an antirabic section was formed and antirabic treatment for over four thousand persons bitten by rabid animals was issued during 1925. A well equipped Pharmacological section for the study of indigenous drugs was opened in 1923 and a few months later a Biochemical section was added. Recent researches have dealt with plague, guineaworm, bilharziasis and sprue, on all of which papers have been published.

The routine work of the laboratory includes the examination of 2,000 rats daily for the Health Department of the Bombay Municipality, of pathological specimens for hospitals and practitioners, of water supplies and the extraction of the venom from cobras and Russell's vipers for the preparation of antivenene.

J. MORISON.

* THE WORK OF THE INDIAN CENTRAL COTTON COMMITTEE.

The Indian Central Cotton Committee was appointed by the Government of India in 1921 as an advisory committee, and by the passing of the Indian Cotton Cess Act in 1923 was incorporated as a permanent body with funds of its own. It is a unique organization for on it all sections of the Indian Cotton Industry,

viz., growing, marketing, export and spinning, are represented, and its members include representatives of the growers, of the Agricultural Departments in the cotton-growing provinces as well as of all sections of the trade, and it provides a common meeting ground where the various sections can become acquainted with each other's difficulties and views. The work of the Committee falls into two sections, *viz.*, constructive action for the improvement of cotton marketing, including the promotion of legislation when necessary and provision for research. Considerations of space forbid any attempt to dwell on the Committee's activities in the first of these three directions, but it should be stated that their importance lies in the fact that unless the grower can realise the financial gain which improved cultivation should give the results of scientific research cannot be exploited.

The Committee maintains its own Technological Laboratory in Bombay (Director, Mr. A. James Turner, M.A., B.Sc., recently Professor of Textiles in the University of Manchester) and provides for the encouragement of agricultural research on cottons by means of grants-in-aid. The Institute of Plant Industry, Indore, which is financed by the Committee in co-operation with the contributing Central India States, is devoting itself primarily to botanical, physiological and agricultural investigations on Cotton. The Committee is also endeavouring, by means of research grants to Provincial Departments of Agriculture, to provide for fundamental investigations which would otherwise not be undertaken. While the improvement of cotton growing is, and must remain, one of the most important functions of the Provincial Departments of Agriculture in the cotton-growing provinces there are many problems of general application the solution of which is essential to the steady progress of cotton growing but which lie somewhat outside the scope of individual departments. By means of these grants full advantage is taken of the existing staff, land, laboratories and equipment. In the promotion of cotton research the Committee are not only following a definite policy but have adopted a definite programme of work. Amongst the investigations so financed are the following :—

In the Bombay Presidency.

- (a) The improvement of the Upland type of cotton by hybridisation,
- (b) The cotton wilt disease,
- (c) The physiology of the cotton plant in Gujarat with special reference to bud, flower and boll shedding, and
- (d) A study of the spotted boll worm (*Earias spp.*)

In the Central Provinces and Berar.

- (a) The genetics and physiology of the 'Oomras' cottons with a view to improvement in staple and yield.
- (b) The cotton wilt disease.

In Madras.

- (a) A general study of the 'Herbaceum' constituent of the various cottons of the presidency with a view to the isolation of types of economic value.
- b) A scheme has also been approved recently for physiological work at Coimbatore on bud, boll and flower shedding on Cambodia, Indicum and Herbaceum cottons and for a study of the cotton stem weevil (*Pempheres*) with the special object of isolating and testing resistant strains including a study of the reasons underlying the resistance of certain strains to insect attack.

In the United Provinces.

An investigation into the control methods necessary to prevent or reduce the damage caused by the pink boll worm (*Platyedra gossypiella*) has been undertaken and has already yielded results of importance.

In the Punjab.

The Committee's research scheme in this province provides for a study of the Botany and Physiology of the Punjab cottons with special reference to the American type under canal colony conditions including a study of the water requirements of the plant.

*** THE COTTON TECHNOLOGICAL LABORATORY.**

Members of the Congress will have an opportunity of visiting the Laboratory and seeing the work in progress. The Spinning Laboratory is provided with a complete miniature spinning plant and the Research Laboratory is equipped for the study of the fibre characters of the various Indian cottons. The Spinning Laboratory, which has been at work since April 1924, has provided a long-needed facility for Agricultural Departments since actual spinning tests are now conducted on 5 lb. samples of cotton, thus enabling the spinning value of new cottons to be determined with some approach to accuracy during the early stages of the plant-breeder's work. The importance of this provision for spinning tests can hardly be over-estimated, yet, in itself, it is insufficient. The ultimate aim of the Research Laboratory is to determine the bearing of the various measurable characters of the fibre on spinning value. Eventually it should be possible to design laboratory methods of fibre examination which will be applicable at an even earlier stage of plant-breeding work than the spinning test and which will enable such work to be conducted with great precision.

The Spinning Laboratory was opened by His Excellency the Viceroy, Lord Reading, on December 3rd, 1924, who at the same time laid the foundation stone of the main Research Laboratory which has since been completed.

B. C. BURT.

* INDUSTRIAL BOMBAY.

The City of Bombay owes its origin to its magnificent harbour, and to its close proximity to the two greatest crossings over the barrier of the Western Ghats. It lacks the advantages which Calcutta possesses in nearness to the coal fields, and in the river system of Bengal, but the harbour of Bombay, unlike the Port of Calcutta, opens directly on the sea. The City has thus become the centre of a very large commercial traffic.

The principal industry of the City is the spinning and weaving of cotton, which comes to it chiefly from Gujarat and the Deccan. The import of coal from England facilitated the starting of the first cotton mill in 1851 by a Parsi, Mr. C. N. Davar. Much of the capital in the industry was originally derived from the profits made in the opium trade with China, and from the money brought to the City by the cotton boom of the 'sixties.' The pre-eminent position of Bombay City in the Indian cotton industry is exhibited by the following figures:—

	<i>Bombay Island.</i>	<i>All India.</i>
Number of mills	82	336
Number of spindles	3,428,000	8,313,000
Number of Looms	71,000	151,000
Average number of hands employed..	148,000	357,000
Approximate quantity of cotton consumed in bales of 392 lbs. ..	821,000	1,918,000

The City produces nearly half the quantity of cotton goods made in India, though they are mainly confined to the lower counts. The labourers consist mostly of Marathas of the cultivator class from the Deccan and Konkan. Owing to the lack of space, the mill hands live in chawls,—buildings several stories high—divided into a number of single room units. In the past these were frequently over-crowded, and the resulting congestion intensified the effect of epidemics, which were a serious problem in the labour supply of the City. Various schemes were put forward for the improvement of the housing conditions of the City; and the work done in this direction by the Bombay City Improvement Trust and the Development Directorate is described elsewhere.

Associated with the cotton industry are 14 separate bleaching and dyeing factories employing over 3,000 hands, and two silk mills and two woollen mills employing as many more. Next to the textile industry the most important group of factories includes the railway works, tramway shops, dock-yards, engineering factories, foundries and metal works. These

employ nearly 30,000 people, of which more than half are engaged in the railway and tramway shops. The works of the G. I. P. Railway at Matunga and of the B. B. & C. I. Railway at Parel are principally devoted to the construction and repair of all railway equipment. The Royal Indian Marine Dockyard dates from the time when the City was famed for its wooden sailing ships built under the superintendence of Parsi shipbuilders. The dockyards employ about 5,000 men, other engineering workshops an additional 3,000, while 40 iron and brass foundries and metal factories absorb 4,000 more.

Printing is another prominent activity. The presses number over 40 and the employees about 6,000.

The tanning and leather industry has been in a depressed state since the termination of the war.

Considerable progress in the manufacture of medical and surgical appliances and medical stores has been made both at the Government Medical Store Depot and at the works of a private firm.

The principal educational institutions of industrial interest are the School of Arts and the Victoria Jubilee Technical Institute.

The School of Arts has special workshops devoted to the instruction of craftsmen. The crafts taught include house painting and decorative work, metal work, chiefly in brass and copper, but also in silver, leading up to ornamental repousse work, carpet weaving, carpentry, wood carving, light smiths work and stone carving. The classes are well attended by the sons of actual craftsmen. A pottery department has carried out considerable experiments in the manufacture from Indian clay of all kinds of ceramic work.

The Victoria Jubilee Technical Institute founded in 1887 provides instruction in Mechanical Engineering, Electrical Engineering, Plumbing and Sanitary Engineering, Textile Manufacture, and Technical Chemistry. In 1923 it removed to the splendid buildings in which it is now housed at Matunga where 160 students can be admitted annually to the five courses which are each of four years' duration. Although priority is given to students belonging to the Bombay Presidency, many students are admitted from other provinces. Since 1923 special Saturday classes have been started for local apprentices and have been very successful. Although not yet fully developed, these classes are now attended by about 300 students.

The disadvantage which Bombay suffers on account of its distance from the coal fields has been partly compensated for by its proximity to the steep scarp of the Western Ghats which affords facilities for the generation of hydro-electric power. The first of these schemes, carried into execution by the enterprise of

Messrs. Tata Sons, Limited, was the Tata Hydro-Electric Power Supply Scheme which at present consists of three lakes (the largest of which covers, when full, an area of five square miles) and produces about 40,000 H. P. for a 12 hour day. The power station at Khopoli consists of five generators capable of producing 10,000 kilowatts at a pressure of 5,000 volts under a fall of 1,725 feet. The power is carried to Bombay, a distance of 42 miles, by 2 transmission lines at a pressure of 100,000 volts.

The second scheme has its water storage in the Andhra Valley after which it is named. In this scheme the water is drawn off through a tunnel 8,700 feet long driven in solid trap rock through the scarp of the Ghats. The generating station is at Bhivpuri, about 17 miles from Khopoli. The scheme is designed to yield 60,000 H. P. after full development.

At present these two schemes supply 44 cotton mills with power. They also supply the whole of the electric power required by the Bombay Electric Supply and Tramways Co., Ltd., and by the harbour branch of the G. I. P. Railway, and will soon supply power to the Bombay-Kalyan Section of the same railway.

To meet further demands from Bombay factories and the railways, a third scheme, the Nila-Mula Scheme, is now in progress of execution. The volume of water in this scheme will suffice to generate 150,000 H. P. and the length of the transmission line to Bombay will be 76 miles. Half of the scheme, that is, for the supply of 75,000 H. P. is expected to come into operation in about three years.

Nearly 100 miles from the Nila-Mula dam a scheme in the valley of the Koyna river has been under investigation for several years. This scheme has in sight a normal supply of 250,000 H. P. The railways and industries of Bombay will thus have ultimately at their command a supply of half a million H. P.

R. D. BELL.

* CITY OF BOMBAY IMPROVEMENT TRUST.

In 1897 the Government of Bombay became extremely anxious on account of the insanitary condition of the Presidency City and prevalence there of Bubonic Plague. As a result of their consideration of this question, the Improvement Trust came into existence on the 9th of November 1898 under Bombay Act No. IV of 1898, The City of Bombay Improvement Act 1898.

The duties with which the Trust was charged were the designing and carrying out of :—

- (i) Improvement Schemes for the abolition or improvement of slum areas within the City.

- (2) Street Schemes for the provision of traffic routes and the opening up of areas and making them suitable for building sites.
- (3) Police Schemes making provision for the Housing of the City Police.
- (4) Reclamation of Land from the sea with the object of providing building sites.
- (5) The provision in connection with any of the above Schemes of accommodation for housing the poorer or working classes.

The Trust is administered by a Board consisting of 14 Trustees, namely :—

- Chairman appointed by Government.
- General Officer Commanding Bombay Brigade.
- Collector of Bombay.
- Municipal Commissioner for the City of Bombay.
- 3 Members nominated by Government.
- 4 elected by the Municipal Corporation.
- 1 elected by the Chamber of Commerce.
- 1 elected by the Bombay Port Trust.
- 1 elected by the Millowners' Association.

The Board is independent of the Municipality but cannot embark on any Scheme until it has been notified to the Public and to the owners interested and has been sanctioned by Government after consideration has been given to any representation made by Municipality and any objection received from the Public.

REVENUE.

The revenue of the Trust is derived from :—

- (1) Rents received from certain Government and Municipal lands handed over to it at its initiation.
- (2) An annual contribution from the Municipality based on a percentage of the Municipal assessments.
- (3) Rents received from leasing of lands acquired for the execution of the various Schemes.
- (4) Rents from Chawls erected for the poorer or working classes.
- (5) Rents from acquired buildings during the period from the date of their acquisition till the date of their demolition for the purpose of carrying out the Schemes.

CAPITAL.

The capital required for carrying out the Schemes is obtained by borrowing from the Public.

Two loans amounting to £899,000 have been raised in England in the years 1909 and 1910. All other loans have been raised in India and these aggregate Rs. 1,389 lakhs.

Government has also given two grants-in-aid amounting in all to Rs. 54 lakhs.

WORK.

The Trust has taken in hand 69 Schemes of which 52 have been completed, 8 are practically complete and the remainder are either in progress or in the initial stage.

It would be impossible in the space allowed to give any description of the various Schemes which have been carried out by the Trust, but among those completed or nearly completed, the following may be taken as typical of the work done by the Trust in performance of its duty:—

Improvement Schemes.

1st Nagpada, Mandvi Koliwada, Nowroji Hill and Undria Street.

The first three wiped out completely 3 of the most insanitary areas in the City, hotbeds of Plague and other disease. The third was an experiment in trying to improve the insanitary areas without wholesale demolition of existing buildings. It was only moderately successful.

Street Schemes.

Princess Street, Sandhurst Road, Gamdevi, Dadar-Matunga, Sion-Matunga, Worli, Parel (Central), Parel (Northern).

The first two represent the idea of the improvement of slum areas by driving main thoroughfares through them, thereby wiping out these areas and providing traffic routes from West to East of the Island.

The next four represent Street Schemes combining main traffic routes with the provision of large areas of new building sites.

The last two are for the provision of a main traffic route purely, the route in question being the central portion of the Eastern Avenue which is now approaching completion.

Police Accommodation.

The Trust has completed or almost completed 19 Police Accommodation Schemes, housing 107 officers and 1,890 men.

Housing of the Poorer or Working Classes.

The Trust has provided 9,462 one-room tenements housing 43,780 persons, 125 two-room tenements housing 875 persons.

The vital statistics show the enormous improvement obtained by the provision of Sanitary Housing the death-rate in the

Board's Chawls being for the last 5 years less than one-third of the general death rate for the City.

During its existence, the Trust has provided 28 miles of roads and 1,712 acres of new building sites in addition to the sites which have been made available by the wiping out of pestilential slum areas, aggregating 255 acres.

J. F. WATSON.

* BOMBAY PORT TRUST.

The Bombay Port Trust was constituted by an Act of Government in 1873, and was re-constituted under Bombay Act No. VI of 1879. This Act has been amended at various periods since, the last amendment taking place in 1923.

The Port Trust is at present administered by a Board consisting of a Chairman, appointed by Government and twenty Trustees, of whom seven are nominated by Government, five by the Bombay Chamber of Commerce, five by the Indian Merchants' Chamber, two by the Municipal Corporation of the City of Bombay and one by the Bombay Millowners' Association. The whole administration of the Harbour, lighting, pilotage, docks, bunders, railways and landed estate is carried out under this Board.

The Harbour is protected from the monsoon and its approaches are well lighted. The principal lights are, one on Kennery Island about eleven miles south of the extreme southerly point of Bombay, and the other, Prongs Lighthouse on Prongs reef, which is about one mile south of the same point. The extreme range of tide is 18 ft. 7 in. and the range between low and high spring tides is 12 ft.

The Wet Docks consist of the Prince's Dock opened in 1880, the Victoria Dock opened in 1888 and the Alexandra Dock opened in 1914.

The accommodation in these docks is as follows:—

Quayage	23,385	Lin. ft.
Water Area	104½	acres.
Berths inside docks	45	
Transit shed floor area	2,329,061	sq. ft.
Warehouse floor area	915,587	sq. ft.
Cranes	One 100-ton, one 60 ton (floating), one 30 ton, six 6 ton; and one hundred and ninety eight 30-35 cwt. cranes.	
Dry Docks:—	Merewether Dry Dock; Hughes Dry Dock.	
Width	65 ft.	100 ft.
Length	595 ft.	1,000 ft.
Depth (mean H.W.)	24 ft. 5 in.	33 ft. 6 in.

The principal capital undertakings during the last fifteen years have been the Alexandra Wet Docks, the Hughes Dry Dock, the Ballard Pier, the Port Trust Railway, the Ballard Estate, the Mazagon-Sewri and Wadala Reclamations, the Grain Depot, the Cotton Depot, the Manganese Depot, the Bulk Oil Depots, and Pir Pau Pier, and the Antop Model Village.

The Ballard Pier extends for a distance of 1,500 ft., and forms the Ballard Pier Station, at which the largest steamers can lie alongside to embark and disembark passengers and mails; on this pier is the railway station, with direct rail communication to all the railway systems in India.

The Ballard Estate is on reclaimed ground south of the Alexandra Dock and is being developed as a first class business and residential quarter in the centre of the shipping district.

The Port Trust Railway serves the Docks and the Depots by means of a large inter-change yard at Wadala. Over 100 miles of track have been laid and the Trust owns and operates 34 main line engines and 685 wagons.

The Mazagon-Sewri Reclamation, at the North end of the Harbour, comprises 583 acres, and on it several of the depots have been placed, besides increasing largely the accommodation for Bunder traffic.

The Wadala Reclamation is not yet completed, but on the completed portion the inter-change yard, Antop Model Village, Bulk Oil Installations, and other industrial works are situated.

The grain Depot consists of six sheds, 1,000 ft. long and seven sheds, 500 ft. long, each 110 ft. broad and completely rail and road served.

The Cotton Depot is probably the largest of its kind in the world. It was opened in March 1923 and provides covered accommodation for one and a half million bales and uncovered accommodation for another million. The depot covers an area of 432,500 sq. yds., and is complete with stations, roads, railway yard, passenger station on the G. I. P. Railway, Merchants' Offices, Cotton Exchange Hall, etc., and is fully protected by a fire service and the installation of Grinell Sprinklers. The cost of the Depot was £1,135,000.

The Manganese Ore Depot cost five lakhs and has a capacity of 160,000 tons, being served by four miles of railway track.

The Bulk Oil Depots hold large quantities of petrol, kerosine, and liquid fuel. The Trust have laid several additional pipe lines both for discharging and bunkering with liquid fuel; the imports in this commodity having increased from nine million gallons in 1917-18 to fifty-seven million gallons in 1924-25.

The Bulk Oil Pier at Pir Pau was opened in 1922 and cost 80 lakhs. It comprises a pier 600 ft. long, with 30 ft. of water along-

side at low tide; two steam pumping stations, approach pier 2,000 ft. long, and about six miles of 8" and 10" pipe line. Until this Pier was put into use, all petrol used in Bombay was imported in tins, some of which was brought in by railway. The imports in 1921-22 amounted to only 757,000 gallons, but in 1924-25 the figure rose to 6,254,000 gallons. In consequence of the construction of the Bulk Oil Pier, the price of petrol in Bombay has been considerably reduced and Bombay is now able to supply large areas inland.

The Antop Model Village is at the North end of the Trust's property and is being gradually added to each year. At present it consists of 71 blocks comprising 508 units, housing 1,706 persons. The Village is laid out on open lines, with single storied cottages and is much appreciated by the inhabitants. The Trust have also on other parts of their property houses for their officers, staff and labourers and house altogether 5,553 persons.

The following figures shew the gross revenue of the Trust since 1917-18 :—

			Lakhs.
1917-18..	..	..	..178.30
1918-19..	..	..	..192.62
1919-20..	..	..	..196.90
1920-21..	..	..	..222.97
1921-22..	..	..	..217.17
1922-23..	..	..	..259.62
1923-24..	..	..	..260.71
1924-25..	..	..	..273.76

The increase is in a measure due to extra charges, owing to the heavy increase in cost of wages and material, but the value of the trade of the Port has risen from 182 crores in 1917-18 to 359 crores in 1924-25, or nearly double. The tonnage of cargoes handled by the Port rose from 4,390,000 tons in 1918-19 to 6,459,000 in 1924-25.

The Trust possesses nine dredgers, some of the very largest type, nine steam hopper barges, and a rock-breaker, besides numerous other craft. The dredgers are employed regularly in deepening and maintaining the channels and approaches.

The total Capital expenditure amounts to Rs. 2,283 lakhs. The total debt of the Board is Rs. 2,269 lakhs and the amount of invested funds and unspent balances at the end of the year 1924-25 was Rs. 561 lakhs.

W. H. NEILSON.

* TATA HYDRO-ELECTRICAL PROJECTS, BOMBAY.

ORIGIN.

One of the most enterprising of Hydro-electric projects was represented to Mr. Jamsetji Tata, some thirty years ago by Mr. Gosling, an architect of Bombay, for the utilization of the monsoon rainfall on the Ghats that form the eastern horizon of Bombay by impounding and storing the waters in the valleys formed in the range of mountains at the high level of the Ghats.

Previously, these waters formed the monsoon rivers which finally flowed into the sea, but by building masonry dams across selected valleys, these waters are impounded and reserved for converting into Hydro-electric power.

Valleys were chosen in situations suitable for conveying the waters by pipes passing down the hill side of the Ghats to the Generating Stations, situated at the foot of the Ghats where the Turbo-Generators are housed, and with regard to vicinities having the greatest rainfall and collecting area, the latter being several times the area of the lakes.

The quantity of water impounded each season amounts to thousands of millions of cubic feet which represents millions of units of electrical power capable of being transmitted long distances and distributed to consumers.

A remarkable feature is the natural formation of the lakes at a high level on the top of the Ghats, the moderately steep descent of the Ghats for the lay of the pipe lines supported on their bearers and anchor blocks and entering the Hydro-Turbine section of the Generating Station at a low level or foot of the Ghats, and most important of all the level of the lakes with regard to the level of the hydraulic turbines giving a static head equal to the highest on record in the world.

Following the representation of the Hydro-electric possibilities to Mr. Jamsetji Tata, he took up the proposal energetically, foreseeing the benefit it would yield to his native City of Bombay and its environments.

He was assisted by his sons, Sir Dorab and Sir Rattan Tata, who, after the lamented and unfortunate death of Mr. Tata, piloted the scheme so enthusiastically that Sir Dorab and Sir Rattan Tata's efforts guided the project to achievement, and after the deeply-regretted death of Sir Rattan, Sir Dorab was assisted by Mr. R. D. Tata.

Mr. R. B. Joyner, M.I.C.E., was invited by a London Syndicate to investigate and see whether the project was financially feasible, and if so, to prepare plans and estimates.

The result was favourable and Lord Sydenham, then Governor of Bombay, recognizing the utility of the project to the country,

suggested that the work might be carried out with Indian support. The proposal was taken up by Messrs. Tata Sons, backed by many of the leading Chiefs of India and wealthy men of Bombay.

Mr. Alfred Dickinson, M.I.C.E., was called in, as General Consulting Engineer and Mr. H. P. Gibbs, the Consulting Engineer's representative in India, who, together with other officers of the staff, carried on the consulting engineering work and supervision of construction and operation.

Power was switched on by the courtesy of Lord and Lady Willingdon on February 8th, 1915.

SCHEMES.

The pioneer Hydro-electric project of the present group of power supply companies was the Tata Hydro-Electric Power Supply Co., Ltd., which, as an example, proved itself an enterprise of valuable utility and successful engineering.

Due to the ever increasing demands for electric powers Mr. H. P. Gibbs brought forward a second scheme which was taken up by the Andhra Valley Power Supply Co., under the same agency of Tata Sons, the consulting engineering work and supervision of construction and operation being carried out by Mr. Gibbs, then General Manager of the Company, together with his original staff of officers. Sir Michael Nethersole officiated as the Company's Chief Hydraulic Engineer.

The second scheme followed much on the same lines of the first undertaking. Power was switched on on October 9th, 1922.

The third project being the Nila-Mula scheme of the Tata Power Co., which is at the present time under construction. The latter Company's works will be the greatest enterprise of the Hydro-group.

Mr. Gibbs was also the originator of the Nila-Mula scheme, which was taken up by the Tata Power Co. under the same agency of Tata Sons. The consulting engineering work being carried out by a newly formed Tata Engineering Co., under the direction of Mr. Gibbs and his original staff. The consulting engineering department is established under American and British expert supervision, who carry out consulting engineering work for prospective enterprises of other companies on application and reference to the Tata Engineering Co.

FIRST DEVELOPMENT.

With regard to the first installation of the Tata Hydro-Electric Power Supply Co., the following summary remarks will relate the lay-out and constructional work.

There are three lakes, viz., Lonavla, Walwhan and Shirawta, with an additional small reservoir, Kundley, which is really

a provision for increasing the catchment area, its waters flowing into the Shirawta Lake, *via* a tunnel through an intermediate mountain range. The Lonavla Lake is small in capacity, compared with Walwhan and Shirawta, the latter being the largest of the lakes. The Lonavla Lake serves as a monsoon supply to feed the hydraulic-turbines, whilst the larger lakes are filling up. The Shirawta Lake feeds into the Walwhan, also *via* a mile through intermediate mountains which is just short of a mile long. The full supply level of the Walwhan is the outlet level of the Shirawta.

The water is let out of the Walwhan into a tumbling bay of a duct line leading to the forebay and is regulated by sluice gates. The Lonavla Lake serves into this main duct line.

From the forebay, the pipe lines commence with two 7 ft. to 6 ft. diameter pipes, leading to the valve house, close to the G. I. P. Railway reversing station and from there 42 inch to 38 inch diameter hydraulic pipes descend the hill individually to each hydraulic turbine situated in the Khopoli Generating Station.

The installation of the Generating Station consists of five 10,000 KVA 5,000 volts 3 phase units and lately a sixth unit has been added to comply with the Kundley Lake extension and provision is made for the hydraulic and electrical control of the power units and transmission of electrical energy or 50,000 KVA capacity by overhead transmission lines from Khopoli to the Parel Receiving Station, the overhead lines crossing the harbour waters of Thana Creek on their way to the Receiving Station. From the Receiving Station, the distribution is made by underground three-phase electric cables through the congested streets of Bombay to feed the various consumers.

The 100,000 volt 3 phase supply of the power station is connected *via* selector switchgear to the transmission lines, the latter being two 3 phase circuits supported by six unit disc type porcelain insulators from steel angle braced structures 40 ft. high to the lowest cross arm, the conductors being spaced 10 ft. apart.

The span between these structures is 500 ft. nominally and the overhead conductors have a sag of 13 ft. providing a factor of safety of 4. The crossing of the harbour waters presented a difficult engineering problem in having to provide spans of over one thousand feet with a clearance of 80 ft. to allow the passage of vessels under the transmission lines.

The two 100,000 volt circuits enter the Receiving Station *via* the lightning arrester rooms or towers, one circuit per tower and through control switchgear to omnibus bars, the latter selecting energy to batteries of 3 single phase transformers, delta connected.

These batteries of transformers convert the electrical energy from 90,000 volts to 6,600 volts, a convenient voltage for the distribution system to the various consumers.

Each consumer has a transformer sub-station on the premises converting the electrical energy from 6,600 volts to 2,000 volts, at which electrical pressure, distribution to the various department motors is made by underground cables.

Mr. Alfred Dickinson considered that all his engineers and contractors deserved credit in their respective work and though unusual, their names are mentioned with regard to his original project and also for the subsequent undertakings as follows:—

The Tata Hydro-Electric Power Supply Co., Ltd.

Hydraulic Works	..	..	Pauling & Co., Ltd.
Turbines, Pipe Line and Headgear	..	..	Escher Wyss & Co.
Power transformers and Switchgear	..	..	General Electric Co., New York.
Generators	..	..	Siemens Bros., Stafford.
Line towers and insulators	..		Bullers, Ltd.
Mill equipments and transformers	..	..	British Westinghouse Mfg. Co.
Cable distribution	..	..	Callenders Cable and Construction Co., Ltd.
The second installation:—	<i>The Andhra Valley Power Supply Co., Ltd.</i>		
Hydraulic Works	..	..	Departmentally under Sir Michael.
Pipe Line and Headgear	..		Kellogg Co., New York City.
Sluice Gates	..	..	Ransome and Rapier, England.
Turbines	..	..	Pelton Water Wheel Co.
Generators, transformers and switchgear	..	..	General Electric Co., New York.
Line tower work	..	..	Departmentally.
Insulators	..	..	Hewlett and Jeffrey Dewitt.
Mill equipment and transformers.			British Westinghouse Mfg. Co.
Cable distribution 22,000 volts	..	..	Callenders Cable and Construction Co., Ltd.

The third installation :—Nila-Mula—*The Tata Power Co., Ltd.*

Hydraulic Works	..	..	Departmentally.
Pipe Line and headworks	..	..	Boving & Co.
Valve gear and Sluices	..	..	Glenfield and Kennedy.
Turbine generators	..	..	English Electric Co.
Power House main transformers	..	..	Ferranti, Ltd.
Switchgear	..	..	British Thomson Houston Co.
Receiving Station main transformers	..	..	English Electric Co.
Switchgear	..	..	British Thomson Houston Co.
Line towers	..	..	Departmentally.
Insulators	..	..	Hewlett and Jeffrey Dewitt.
Mill equipments and transformers	..	..	British Westinghouse Mfg. Co.
Sub-station equipment for railway transformers	..	..	English Electric Co.
Do. switchgear..			British Thomson Houston Co.
Substation equipment for tramways, transformers	..	..	General Electric Co. of New York.
Do. switchgear..			British Thomson Houston Co.

SECOND DEVELOPMENT.

With regard to the Andhra Valley Power Supply Co.'s installation, the system follows, as nearly as possible, the Tata Hydro-Electric Power Supply Co.'s lay-out with a few exceptions. The Andhra Valley Power Supply Co.'s installation has only one lake impounding 14,500 thousand millions of cubic feet of water and has a remarkably small dam to retain so vast a quantity, *viz.*, 70,000 brass of masonry.

This lake is situated some 12 miles north-east of Lonavla on an upper valley of the Western Ghats. During the monsoons, the impounded waters flow toward the dam and the flow is in the opposite direction under service conditions, *via* the penstocks. A certain amount of water is retained in the bed of the valley maintaining the draw-off R. L. at the dam with regard to the longitudinal contour of the valley forming the lake.

The draw-off and sill level is at the outlet of the lake and entrance to a tunnel 8,700 ft. long, blasted through a mountain naturally forming the end of the lake; hence the water is conveyed through the tunnel to the pipe lines.

A surge chamber is built near the outlet of the tunnel, and under static conditions, the surge chamber will be full of water up to the water level of the lake, *viz.*, R. L. 2,195 HWL.

The function of the surge chamber is to relieve any undue stresses that may arise due to the cutting off of the supply by the penstock valves or the arrest of the flow of water from any other cause.

Under such circumstances, the water would rise in the surge chamber just sufficiently to balance the momentum of the flow.

One only manifold pipe, 10 ft. diameter, is built in the outlet of the tunnel whose branches connect with individual pipe lines passing down the hill side to each hydraulic-turbine installed at the Bhivpuri Generating Station. The Generating Station is of 50,000 KVA capacity, with one 10,000 KVA as spare and used on maintenance service. The Generating Stations at Bhivpuri and Khopoli have a tie transmission line for interchange of loads. The Andhra transmission lines and Receiving Station are similar to the Tata Hydro provisions, with the exception that the main banks of transformers have a ratio of the transmission line voltage, *viz.*, 90,000 to 22,000; thus the distribution of electrical energy to consumers by underground cable is at 22,000 volts, the consumers, transformers being designed to convert same to 2,000 volts for their motor distribution purposes. With this installation, the principles of arranging the phasing from the generator windings to the distribution is of the delta-star order, allowing of a neutral grounded point in the star, the original phasing is of the delta order.

THIRD DEVELOPMENT.

With regard to the progress of the Nila-Mula scheme, which is now under construction, the dam is being built at Mulshi, the Pipe Line and Power Station at Bhira and the Receiving Station at Dharavi, abutting the Andhra Valley Receiving Station. The transmission line crosses Thana Creek alongside the Tata Hydro transmission lines. The distribution to consumers is at 22,000 volts, similar to the Andhra Valley supply, only the system of network of the underground electric cables is modified by reducing the number of feeders to consumers, that is to say, several consumers are supplied from each feeder and a provision of a ring main serves as a duplicate feed.

The Receiving Station of the Tata Power Co. is capable of working in conjunction and directly with the Andhra Valley Receiving Station, as also, with the Andhra and Parel Receiving Station on the 100,000 volt supply by an interconnecting tie transmission line.

The Generating Station units are of 20,000 KVA capacity, aggregating 120,000 KVA, with provision for future extensions. The generators are wound for 11,000 volts, 3 phase currents and connected star method with selective ground provision, and although this plant is of double the unit capacity of the Tata Hydro, the current capacity of the cable, switchgear, bussbars, etc., as regards each unit remains the same.

Hydraulic turbines are fitted to each end of a generator shaft, thus the turbines are also of the same capacity, as the original lay-outs. The aggregate output being more than the original installations, reactors are inserted in the bussbars lines in order to limit any fault currents that may arise from the increase of the unit capacity and aggregate capacity of the installation. Similar reactors are inserted in the Receiving Station bussbars lines for the same purpose. Larger unit banks of transformers are also installed at the Generating and Receiving Stations, corresponding with the capacity of the Generators.

All the three Companies' Receiving Stations have 12,000 KVA units of rotary condenser plants which correct the power factor of the electrical output and improve the regulation, the loss in driving these condensers is - only approximately 500 H.P. per unit.

On the completion of the Nila-Mula project, a further description of other works and details will probably be written to accompany the papers already given in various institution proceedings.

References may be made to an address given by Mr. Alfred Dickinson, M.I.C.E., in April 1915, before the Institution of Electrical Engineers, London, and copy of same may be read in Indian Textile Journal Vol. 25 and 26, also Proceedings of the Institution of Civil Engineers, London, Vol. CCVII, Session 1918-19, Part I, by the late Robert Batson Joyner, C.I.E., M.I.C.E. and Mr. B. D. Richards, M.I.C.E.

The journal of the Institution of Engineers (India) on Andhra Valley by the author, Vol. III, April, 1923.

GENERAL REMARKS.

The three Companies, combined plant will aggregate just over a quarter of a million horse power and they are so interconnected that the three installations may operate in conjunction for any disposition of load distribution.

Since the extensions to the primary Company, The Tata Hydro-Electric Power Supply Co., which had cotton, wool, flour, ice, and other factories, as consumers, the G. I. P. and B. B. and C. I. Railways, also the Bombay Tramway Company,

have contracted for bulk supply of electrical energy for traction and lighting purposes, and applications for electric power still flow in and this in itself proves the ever increasing demands of the City of Bombay enterprising people and their desire to advance by the utility provisions knocking at their door and improve their workings and operation of their undertakings. Great possibilities and prospects are expected with the Nila-Mula scheme and having the largest capacity of the group of Hydro-Electric developments, it will not only be capable of answering to its already large registration of new customers, but will meet other future consumers' requirements.

Schedule of Capacities.

Lakes.	Height. (feet).	Length. (feet).	Full capacity million Cu. ft.	Static head. (feet).	Catch- ment sq. miles.	Discharge Cusecs.	KVA Capa- city.
Lonavla ..	33	3,615	361	1,723	5.4	..	..
Walwhan ..	76	4,500	2,600		5.5	..	..
Shirawta ..	96	7,650	7,500		11.0	..	..
Kundley ..	155	1,597	500		11.7	480	60,000
Andhra ..	190	1,850	14,500		1,748	48.0	480	60,000
Nila-Mula ..	150	2,900	16,250	1,515	95.6	960	1,20,000

J. F. HEATH.

* NOTES ON THE BOMBAY GAS CO.'S WORKS AND
DISTRIBUTION SYSTEM.

The Bombay Gas Works and Distribution system for supplying the Island of Bombay and Bandra are owned by the Bombay Gas Co., Ltd., (Incorporated in England), whose Head Office is in London. The Company were given the necessary power for a Public Supply under Bombay Act No. V of 1863, which has been modified from time to time. The Paid-up Capital to-day stands at £300,000. The Works stand on a site of over 9 acres and were designed by Mr. Thos. Hawksley of Hawksley Bros., Civil Engineers, Westminster, and the erection of same started in the year 1863. Gas was supplied for the first time in Bombay in 1866.

To-day very little of the original plant exists as extensions and alterations have had to be made to meet with the ever increasing demand for gas. The present plant has a daily producing capacity of approximately 3,180,000 c. ft. of Coal Gas and 320,000 c. ft. of Water Gas or over 3,500,000 c. ft. daily.

The Coal Stores are arranged with a Railway Siding to store some 18,000 tons of coal. The Retort Houses are equipped with two Benches containing 25 "through" Settings of Retorts all built on the Regenerative Principle. The total number of Retorts being 300. The Coke removed from the Retort House is taken out on the Coke ground which has a storage capacity of some 1,000 tons. The coal carbonized in normal times are purchased from Bengal. The Water Gas Plant is one of the latest and most improved type and is a complete unit in itself with the necessary powerful Steam Generating Plant, Blowers and Steam Turbines, etc.

The Coal Gas Plant consists of both Annular and Water type Condensers, Tower Scrubber and two large Rotary Washers, also extensive Tar storage and Ammoniacal Liquor Wells and Tanks with the necessary tar distilling plant. There are also three Rotary Exhausters exhausting the gas from the Retort Houses and forcing same through the various washing and Scrubbing Plant on its way to the dry purification plant which consists of seven Purifiers capable of holding over 1,000 tons of Oxide of Iron. The gas after leaving this plant is then registered by three large Cylindrical type Station Meters and allowed to go forward to the 3 Gas Holders for storage and distribution purposes on the District, the latter after passing through the 3 Station Governors which control the pressure.

The Works are equipped with an up-to-date Chemical Laboratory where constant analysis of the gas being manufactured and sent out is being tested for calorific power, illuminating power and percentages of composition of the gas.

The Distribution System consists of some 200 miles of cast iron mains varying in size from 24" down to 3", service supplies represent some 400 miles of piping varying from 2" down to $\frac{3}{4}$ "; these in turn supply some 8,000 public street lamps and in addition over 12,000 consumers with gas for light, heating and power purposes.

There are several stations throughout the Island for compressing gas for use on High Pressure gas installations both for Public Street Lighting and for Industrial purposes. An example of the latest type having been installed at the Britannia Biscuit Company's Factory at Kassara Basin. Gas is being used more and more daily for large cooking installations in clubs, hotels, hospitals and chemical laboratories, etc., and by many thousands of household consumers on account of its high efficiency, cleanliness, convenience and low cost compared with other heating agencies.

WILLIAM T. LANE.

* THE BOMBAY ELECTRIC SUPPLY AND TRAMWAYS COMPANY, LIMITED, SYSTEM.

The Bombay Electric Supply and Tramways Company purchases its supply of electrical energy in bulk from the Companies comprising the Hydro Group, of which Messrs. Tata Sons, Limited, are the Agents. Energy is received in bulk at the Bombay Electric Supply and Tramways Company's Receiving Station at Kassara Basin, Mazagon, and at four Sub-Stations through :—

- (1) Induction Regulators—9,000 K.W. at 6,600-5,500 volts at Kassara ;
- (2) Transformers—21,500 K.W. at 22,000-5,500 volts at Kassara ;
- (3) Transformers—3,000 K.W. at 6,600-5,500 volts at Esplanade Sub-Station ;
- (4) Transformers—3,500 K.W. at 22,000-6,600 volts at Kingsway Sub-Station ;
- (5) Transformers—1000 K.W. each at 6,600-400-230 volts at Lalbag and Suparibag Sub-Stations.

The H. T. Supply at Kassara is distributed through E.H.T. Feeders to about 60 Static Sub-Stations. The E.H.T. Network consists principally of 15 sq. inch E.H.T. 3 core P.I.L.S. Cables, laid on the solid system, at a depth of about 3 feet.

The H. T. Voltage is reduced in the Static Sub-Stations from 6,600 or 5,500 to 230 volts. 4 wire A.C. Supply is thus available to the public in areas supplied with Alternating Current at 230 volts, 50 periods, for lighting, and 400 volts for power purposes.

In the Fort Area, however, the supply, 3 wire D. C. at 230 and 460 volts, is obtained from 2 Rotary Sub-Stations equipped with Rotary Converters and H. T. Motor Generators.

The L. T. Network consists largely of 4 core Armoured Distributors chiefly of the following sizes : '2, '1 and '05 sq. inch. The D. C. Network in the Fort Area consists chiefly of '2, '1, '2 V.B. Combination.

Armoured Cables are laid directly in the ground at a depth of about 2'-6". L. T. Cables are rarely laid on the solid system except for the V. B. Combinations. Wherever possible, all cables are laid under footpaths.

The important rates charged for energy to the public per Kilowatt Hour are :—

Lighting and Fans—4·5 and 4·0 annas per unit for business and residential premises respectively ;

Power—For motors from 5 B.H.P. to 10 B.H.P. 2 annas per unit. For motors above 10 B.H.P. Rs. 8 per K.W. of Maximum Demand per month *plus* 2-3rds anna per unit consumed ;

Heating and Cooking (Domestic)—1 anna per unit.

Public Lighting.—The Company has now installed about 900 electric lamps at various points and on different roads in the City. The Municipal Corporation specify the size of lamps to be erected, and pay yearly rates for the lighting and maintenance thereof.

Tramways.—The Tramways Rotary Sub-Stations are situated at Esplanade, Kassara and Kingsway, where H. T. Supply is converted into D. C. Supply at 550-600 volts by Rotary Converters and High Tension Motor Generators.

The Distribution System consists of Positive Feeders (mostly 5 sq. inch in section) which feed the Overhead Trolley Wire at 18 feeding points. The Trolley Wire used is No. 00 B & S Grooved Copper. Current returns to the Sub-Stations through the rails; Negative boosters at Esplanade Sub-Station and negative feeders are employed to keep the voltage drop within the limits prescribed under the Indian Electricity Act.

The Permanent Way consists of B. S. S. No. 1 and 1c (90 and 96 lbs.) Tramway Rails laid on transverse teak sleepers on either a concrete or rubble bed. Where extra heavy vehicular traffic is prevalent, as in the "Docks Area," the rails are laid and anchored directly on the concrete bed. The track gauge is 4'-8½".

A large portion of the track surface of the Permanent Way which is repairable by the Company, has been treated with Asphalt penetration to minimise dust. Sett stone paving is employed on sections subjected to very heavy traffic. The equivalent length of Single Track is 53.59 miles, of which about 25 miles is Double Track.

The Company owns 520 tram cars, which run singly or permanently coupled together, thus forming 320 car-units. Passengers carried amounted to about 101 million last year, during which the miles run by units were just over 6 million. All tram cars are built by the Company in Bombay, the trucks and electrical equipments being imported from Overseas.

* THE TELEPHONE SYSTEM IN BOMBAY.

BOMBAY can now well boast of being one of the most up-to-date cities in the world in respect of telephonic communication, in view of the fact that The Bombay Telephone Co., Ltd., in May 1924, transferred all subscribers in Bombay from the manually operated system to the Automatic System.

There are two Automatic Exchanges having a total present equipment for 11,000 subscribers' lines, with an ultimate capacity of 30,000 lines. The Central Exchange is equipped for 7,000 lines and the Gell Street Exchange for 4,000 lines, each Exchange

being capable of extension to 15,000 lines. Other Exchanges can be added necessitating very little alteration at Central or Gell Street and in this way the service can be extended sufficiently for 100,000 subscribers.

The Exchanges are fitted with Strowger Automatic Equipment and were installed by the Automatic Telephone Manufacturing Co. Ltd., Liverpool. This equipment of 11,000 lines was the largest initial installation of automatic telephones made in any city of the world outside the U. S. A. prior to 1924.

The chief advantages of the Automatic System are :—

- (1) The speed with which the subscriber can make a call. Almost immediately after dialling the required number, the wanted subscriber's bell is rung. The clearing of the connections after conversation is practically instantaneous. In the event of the wanted subscriber being already engaged, the "busy" signal is given at once.
- (2) The elimination of the manual operator saves the time between the calling subscriber's signal to the operator and the operator's commencement to receive the desired number as well as the time spent in the physical movements required to effect the connection. In the case of a call to a subscriber in another Automatic Exchange the saving of time is therefore very marked.
- (3) The conversation is secret and the possibility of an operator listening on the line is eliminated.
- (4) The language difficulty is done away with as the simple numbering scheme of the dial is readily understood by all nationalities. In a city like Bombay with a cosmopolitan commercial population, where many languages and dialects are in use, it is necessary for the operators in a manual exchange to understand and speak several languages. The Automatic System dispenses with the operator and solves the problem.
- (5) A twenty-four hour service is given, for the Automatic Exchange never tires like the human operator and is ready day and night to render the fullest and most efficient service.

The method of operation in calling a number by the subscriber is very simple. On each telephone is fitted a Dial to which is fitted a revolvable disc pierced with ten finger holes with the numbers "1" to "0" behind them. A finger stop is provided on the Dial, and after lifting the Receiver the finger is inserted in the hole opposite the numerical digit required, the disc is pulled round to the finger stop, and then released. This operation is repeated until the complete number is dialled.

During its travel back to the normal position of rest, the dial mechanism transmits the desired number of electrical impulses to the Automatic Exchange. These impulses operate the switches to put through the call to the required subscriber, and the final switch sends out an alternating current which rings the Telephone Bell of the required subscriber.

It is a difficult matter to describe the exchange equipment, without the aid of diagrams or a practical demonstration, but a brief description of the items of Automatic Equipment, and what occurs at the Exchange when a call is being made may be of interest.

Each subscriber's line on entering the exchange passes through the Main Distribution Frame which is equipped with protective devices to safeguard the line and apparatus from lightning discharges or accidental contact with electric light or power mains. From the Main Frame the line is connected to a Rotary Line Switch, one such switch being provided for each subscriber's line. These switches, along with other associated line and cut-off relays, are mounted in groups of 100 on a framework of substantial steel construction. On the other side of this unit the Final Selectors or Connectors are arranged in shelves of eight connectors per shelf, and each line switch unit has capacity for four shelves, or thirty-two connectors in all.

The actual equipment of connectors depends on the amount of traffic flowing through the exchange, of which a careful study must be made when designing the exchange.

The rotary line switch on which each subscriber's line terminates is a selective switch provided with an electric motor mechanism with ratchet and pawl motion, operating a shaft fitted with four sets of spring wipers or contacts which are capable of being rotated over a contact bank by means of a step-by-step action.

The contact banks or levels, of which there are four, each have twenty-five contacts with which the wipers engage and make the required contact.

The rotary line switch contact banks are connected by wiring with another type of switch, known as a group selector and the function of the line switch is to select one of the sets of selectors by means of which the call is extended through the switching system.

The group selector is a two-motion switch, and in the trunking scheme is inserted between the rotary line switch and the final selector or connector, the function of the switch being to extend the call in successive stages.

The number of group selectors necessary in any given trunking scheme depends on the numbering system adopted. For

the Bombay exchange area a five digit scheme has been chosen, and a call for an automatic subscriber in the same exchange will involve, first the rotary line switch, and first, second and third group selectors, and finally a connector.

The general assembly of the group selector is somewhat similar to the connector, described in the succeeding paragraph. The relay group and circuit arrangement are, however, different, one of the chief points of difference being the horizontal motion of the wipers, which is not controlled by the subscriber dialling, but is automatically rotated when searching for a disengaged auto-trunk. The vertical motion only is controlled by the subscriber's dial.

The Final Selector or Connector, as its name implies, is the final and most important switch in the series required to connect the calling subscriber with the called station.

The Connector is a two motion switch, that is, the moving shaft to which are attached the wipers which make contact with the banks, is capable of motion in two directions, first in a vertical direction, and secondly in a horizontal radial movement, the separate movements being effected by step-by-step mechanism, the vertical motion always preceding the horizontal motion.

A pressed steel base supports the assembly of the apparatus, the complete switch being readily detachable from its shelf on the line switch unit by means of bayonet slots, and a multiple contact spring jack mounted on the base effects the necessary contacts with the wiring of the unit when the switch is placed into position on the shelf.

The relay group associated with the connector circuit is assembled at the top of the mounting base, eight relays being included in the group of the particular switch under description.

Below the relays is the vertical, rotary, and release mechanism by which the shaft is actuated. At the bottom of the shaft are two sets of spring contact wipers and two sets of bank contacts, the lower one designated the "line bank" and the upper one the "private bank."

These banks are arranged in levels and in radial formation, the wipers making contact as they are moved round with the shaft.

The lower line bank consists of ten levels, each level having ten pairs of contacts to 100 subscribers' lines with a two wire metallic circuit per line.

The upper bank (private) consists of ten levels each level having ten contacts, 100 contacts in all, and is used for the purpose of testing, holding, and guarding the line from inter-

ruption when engaged, and for releasing the line when conversation is finished. It is known in Automatic Telephony as the "release trunk" and does not extend beyond the exchange.

The ten levels of each bank are numbered "1" to "0," number "1" level being at the bottom and the "0" level, which is equivalent to the tenth level, at the top.

The switch shaft is capable of upward movement in ten vertical steps, and the normal position of the wipers is clear of the banks. One vertical step raises the wipers in line for engagement with number "1" level, two vertical steps with the second level and so on upto the "0" level which requires ten steps to reach. After the vertical steps the vertical movement of the shaft is automatically changed over to the horizontal radial movement which is also made in ten successive steps. The contacts in each level are numbered "1" to "0" reading from the left.

From this explanation it will be seen that the wipers can be made to effect contact with any one of a hundred lines. For instance, Number 48 in a particular hundred group would be found on the 4th level and the 8th set of contact in that level.

After conversation, on the subscriber hanging up his receiver, the release mechanism of the switch frees the shaft and wipers and allows them to return to their normal position ready for another call.

As previously explained, the subscribers lines are arranged on line switch units in groups of 100, and in the Central Exchange there are seventy switch groups equipped on seventy line switch units.

The function of selecting the particular thousands and hundreds group is allocated to the group selectors, the final two digits, tens and units being found by the connector.

Briefly, the functions of the connector are :—

- (1) To find a required line in a particular hundreds group.
- (2) To test the line to ascertain if already engaged or not.
- (3) If engaged, to transmit back to the calling subscriber the "busy" signal.
- (4) If the line is free to put ringing current out to the wanted subscriber.
- (5) To hold and guard the line from any interruption while in use.
- (6) On the called subscriber replying, to remove the ringing current automatically and switch the lines through to each other.
- (7) Where a metering scheme is employed, to register the call automatically.

- (8) To furnish transmission current to the called subscriber.
- (9) To release the lines and equipment after conversation is finished.

It will be seen from the above that the connector undertakes practically all of the mechanical duties which are performed by the operator in a Manual Exchange, and does them much more quickly and accurately.

Moreover, it is capable of maintaining the highest possible standard of speed and accuracy without diminution for the whole 24 hour service, when the human operator would break down from fatigue. In the whole science of telephony there is nothing more wonderful than the complete automatic operation of the connector with its manifold functions. What actually happens at the Exchange when a call is made, can best be described by illustrating the procedure of one subscriber connected to Central Exchange, making a call to another Central Exchange subscriber, whose number is 23570.

The sequence of operations is as follows :—

- (1) On the calling subscriber lifting the receiver the rotary line switch associated with his line immediately engages a first group selector and holds it in readiness for the dialling impulses, at the same time preventing any interruption by making the line busy to any other callers.
- (2) Dialling the first " 2 " raises the first group selector wipers to the second level. Immediately on the cessation of the vertical movement of the shaft the wipers automatically rotate to find an auto-trunk to a disengaged second group selector which it at once seizes and holds.
- (3) On dialling the second digit " 3 " the second group selector elevates its wipers to the third level and automatically rotating finds an auto-trunk to a disengaged third group selector which it at once engages.
- (4) The third digit " 5 " causes the third group selector to raise the wipers to the fifth bank level, and automatically rotating finds an auto-trunk to a disengaged connector on the line switch unit having access to the particular hundred lines in which the number 23570 appears.
- (5) The last two digits " 7 " and " 0 " are received by the connector, both motions of this switch are controlled by the dial. The wipers are raised to the seventh level and then rotated to find the tenth contacts on that level to which is connected the line of subscriber number 23570.

- (6) The sequence of operations described in the paragraph under "Connector" now takes place, the required subscriber is rung, and the subscribers are switched through to each other. If the line is already engaged, the busy signal is given.
- (7) On completion of the conversation, and on the subscribers' replacing their receivers, the whole train of switches employed for extending the call through the exchange is immediately released, ready for further calls.

The whole series of operations described at length up to the time of the called subscriber's bell being rung, only occupies an average of eight seconds and the clearing after conversation is effected in less than half a second.

The saving in time is more strikingly shown when a call is made to a subscriber in another automatic exchange, as this is accomplished in the same time as making a call to a subscriber in the same automatic exchange.

In the manual system two operators would be required to complete such a call. To the subscriber, this saving in time is an important asset.

The source of energy for operating the Exchange mechanism and for supplying current to the subscriber's telephones is a 46 Volt Battery of the Chloride Type of 4937 ampere hour capacity at Central Exchange, and one of 3421 ampere hour capacity at Gell Street Exchange. These batteries are charged from 50 Kilowatt Generators direct coupled to 75 H. P. Motors connected to the B. E. S. & T. Co.'s mains, two such sets being installed at each exchange. A motor driven switch of very heavy proportions is installed at each exchange for the purpose of cutting in and out the counter E. M. F. cells, of which seven are installed at each exchange, in order to maintain a constant pressure of 46 Volts whilst the battery is being charged.

Test Desks of the latest type are installed for the purpose of testing the internal circuits of the exchanges, and also the subscribers' outside lines. From these desks, it is possible to test to a fraction of a second the speed of a dial several miles away.

Enquiries and complaints from subscribers are dealt with by a Complaint and Information Desk attended by several operators. So far as Bombay is concerned "If you want to know the time, ask a Policeman" no longer applies—a subscriber simply dials 294, and without even asking a question hears the correct time. Many readers took advantage of the facilities given by the Company to obtain the cricket scores

during the recent Quadrangular Cricket Tournament, by communicating with the Company's Information Department, No. 293.

This Department also supplies subscribers with the latest information as to the times of arrival and departure of the mail steamers and principal trains.

W. A. C. BROMHAM.

* REFRIGERATION IN BOMBAY.

Until 1921 the only plant in Bombay so far as I know was a small installation at Grant Medical College used to store bodies for autopsies in connection with the Coroner's Court. In 1921 a four-roomed plant was installed at the Arthur Crawford Market to store fish and fruit. Each room has a floor space of 600 sq. ft. and a height of 7 ft. with capacity for 21 tons of fish or 33 tons of fruit. The ammonia system is used with Lightfoot compressor and a 60 horse-power electric engine. Three years experiments in storing mangoes in this Refrigerator by the Horti-culturist to Government have this year proved successful.

In 1922 the Taj Mahal Hotel installed a small petrol-engined two-roomed brine system store with one ton storage capacity. An up-to-date installation on brine system with a very efficient ventilating arrangement has just been built at the new Goverdhandas Sunderdas Medical College. It is designed for storing 9 bodies for post mortem and has some original and interesting features. The power unit is electrical.

The Bombay Municipality will erect another small 100-ton plant similar to the one in Crawford Market at the new Chowpathy Market for fish. Work of the market is started. The plant is expected to be working in less than a year.

The Municipality has also acquired a block of land on Pultan Road to erect a large cold store. Financial stringency has prevented its utilization upto now but it is hoped to erect the plant in the near future.

C. M. FLANDERS.

* THE BOMBAY PRESIDENCY RADIO CLUB.

During 1923 local interest began to manifest itself in wireless matters in the shape of letters published in the local press, from individuals who put forward suggestions from time to time for the formation of a Radio Club or Society. These letters apparently met with little response for it was not until a meeting, called by Mr. F. E. Rocher, and held at the Taj Mahal Hotel in the beginning of 1924, that the movement which led to the establishment of the Bombay Presidency Radio Club, took definite

shape. This meeting was attended by about 50 gentlemen, most of whom had already enjoyed the pleasures of broadcasting in other countries and were anxious to see developments of a similar nature in India. The proposal to form a Radio Club was supported unanimously, a small committee was elected to formulate suitable rules for the Club and all present agreed to become members.

The Committee worked rapidly and leased the present Club premises situated in a wing of the Royal Alfred Sailors' Home. In May 1924 the Club was formally opened. His Excellency, the Right Hon. Sir Leslie Wilson, Governor of Bombay, graciously consented to be Patron of the Club which was further extremely fortunate in obtaining the consent of Sir Lawless Hepper, to act as its first President. Many professional and business men gave their services and support and the measure of the success of the venture, may be gauged by the fact that in December of the same year the membership had increased to approximately three hundred.

At the present time negotiations are in hand with a view to removing to more suitable and commodious quarters in order to provide increased facilities for the social activities of the Club.

The Club was founded with the main object of providing an institution to stimulate interest in and foster the study of radio communication and allied arts, and that its object has been at least partially achieved will be manifest to anyone observant enough to note the aerials which are scattered all over Bombay.

A Transmitting Station was erected in May 1924 by and at the expense of The Indian States and Eastern Agency, Agents for Marconis Wireless Telegraph Company on their Ballard Estate premises and by their kindness this Station has been maintained in continuous operation ever since. Many talented members of the Club have freely given their services in providing musical programmes sufficiently varied to appeal to all communities.

The apparatus available was a standard Marconi Type Y. B. 2 Field Station set of 100 watts input to the power valve. In its standard form this set comprises one power valve, type M. T. 3 and one modulating valve type M. T. 5, the control being by standard Marconi choke circuit. In order to make the set more suitable for broadcasting an extra valve was added as a sub-modulator, and in order to make the set reliable and easy to handle one type of valve was used throughout. The Transmitter with its high tension D. C. generator is housed in a wooden hut on the roof of a fifty foot building and connected by lead covered cables to the studio which is in an adjacent building.

The aerial consists of a single wire "T" of 150 feet span supported by two forty feet lattice steel towers, situated one on

the same roof as the hut and the other on an adjacent roof. The earth system is a direct connection to water pipes and tanks situated close to the hut. For convenience the accumulators used for filament lighting are located in a basement near the Studio, where they can be charged without moving.

Various types of receiving sets have been installed from time to time on the Club premises, kindly provided by business houses and members of the Club, several of which have not only reproduced the locally transmitted programmes but have successfully tuned in the Calcutta and Colombo stations and when members have been sufficiently patient and enthusiastic to sit up until the early hours of the morning, London and other European stations, Durban, etc., have been distinctly heard.

A series of lectures have been delivered at the Club which invariably have been well attended.

With the removal of the Club into new premises, should present negotiations terminate favourably, it is anticipated that its activities will develop rapidly and that it will fully supply the facilities and achieve the objects for which it came into being.

F. E. ROCHER.

* DEVELOPMENT DIRECTORATE.

The works under execution by the Development Directorate are:—

- (1) The Back Bay Reclamation,
- (2) Industrial Housing,
- (3) Suburban development for residential purposes,
- (4) Improved suburban communications
and
- (5) The provision of industrial areas in the suburbs and elsewhere.

Owing to the slump in industry and commerce, all schemes have meantime been curtailed as far as practicable.

BACK BAY RECLAMATION.

This reclamation will be contained by a sea wall 21,578 feet in length. The northern end, constructed of mass concrete on a rubble bank, has been completed for 7,980 feet. At the southern end 2,000 feet of mass concrete wall built directly on the reef is continued by 9,741 feet of mass concrete on a rubble mound. The gap of 1,884 feet left in the middle will remain open till dredging has further advanced.

The area enclosed by the wall is 1,145 acres and will be filled at the southern end with material dredged from the harbour and the northern end with material from Back Bay. The dredger "Sir George Lloyd" works in the harbour, assisted by the "Colaba" as a boosting station. About 12,10,000 cubic yards of material have been deposited in the southern area. Dredging at the northern end is not yet in full swing.

Of the total area of 1145 acres, about 250 acres at the Colaba (southern) end are reserved for the use of the military authorities. Of the remainder, 187 acres (eight times the area of the Oval) will be recreation grounds and open spaces. Roads will absorb 239 acres. The remainder, 22 lakhs of square yards, will be available for buildings.

The open spaces and the marine promenade will be important additions to the amenities of Bombay.

The military area in the south will be ready, with murum topping, in 1929. At the same time about 193 acres will be completely reclaimed and partly developed at the northern end and building sites will then be put on the market.

INDUSTRIAL HOUSING.

One room tenements for the working classes have been provided in four parts of Bombay :—

Naigaum	..	..	..	42	Chawls.
DeLisle Road	..	..	..	32	„
Worli	..	..	..	121	„
Sewri	..	..	..	12	„

Each chawl contains 80 tenements and construction is now complete. Rents range from an average of Rs. 7-2-0 per month per tenement at Worli to Rs. 10-2-0 at DeLisle Road. As the "economic" rents are much higher, there is an annual loss on the scheme, when in full operation, of Rs. 15,00,000 annually. This is met from a part of the town duty of one rupee on each bale of cotton imported into the City of Bombay. Owing to adverse economic conditions, accentuated, at the time of writing by the mill strike, the greater number of tenements are not yet occupied.

SUBURBAN DEVELOPMENT.

Communications have been improved. The Bandra-Anandheri Road has been widened and tar macadamed. The Malad-Marve Road, including the construction of a bridge, has been completed. In Trombay, the Kurla-Trombay Road has been widened and improved and the Trombay section of a new road (Kolwada-Borla), giving direct access to Bombay, has been completed. A railway has been opened between

Kurla and Chembur (one of the new Garden Suburbs) and will be continued further east. Another line (the Salsette-Trombay Railway) has been constructed from Andheri, on the B. B. & C. I. Railway, crossing the G. I. P. Railway by an overbridge at Kurla, to Anik in south Trombay. This line was chiefly intended for carrying materials required for the development of the area which it traverses but, owing to the slump in the land market, is not required for this purpose at present. Its use for a tramway service is under consideration.

The residential suburban schemes are as follows:—

Chapel Road, Bandra: 20.2 acres, 144 building plots, of which 133 have been sold.

Khar: 120.6 acres, about 900 building plots, of which 264 have been developed and 208 have been sold. A new railway station has been opened and more roads are under construction. This is a very popular scheme.

Kirol-North (near Ghatkopar Station): 17.33 acres, about 78 building plots, of which 40 have been developed and 15 have been sold.

Chembur: 122½ acres about, 450 building plots, of which 255 have been developed and 77 have been sold.

The development of these residential schemes is encouraged by a scheme of financial assistance under which Government advance at 6 per cent. interest a sum equal to three-fourths the cost of the land and one-half the cost of the building. These advances are repaid in instalments spread over a period not exceeding fifteen years.

There are two suburban industrial schemes—one at Kurla-Kirol (near Ghatkopar) for small industries and one in Trombay, north east, for tanneries, dyeworks and other noxious trades. A new municipal slaughter-house is planned for the same locality. Owing to the general trade slump, work on these schemes has been stopped meantime.

For these residential and industrial areas water-supply schemes have been carried out.

Ambernath: The most important industrial area is at Ambernath, a few miles north of Kalyan. An area of 1,395½ acres has been laid out and separate provision is made for sites for factories, for workmen's quarters and for bungalows for superior staff. The Ulhas river provides a source of water-supply sufficient for all possible requirements and three million gallons of filtered water daily are already available. A central electric power station supplies energy for running the factories and the water pumping plant and for lighting the whole area. (See page 146).

R. D. BELL.

* THE ELECTRIFICATION OF THE G. I. P. RAILWAY.

The electrification of sections of the Great Indian Peninsula Railway, being the first in India, has created a considerable amount of interest in engineering and other circles.

In a short article such as this it is not possible to enter into the detailed considerations which led the G. I. P. Railway to adopt this modern form of transport.

The main considerations were to provide a quick and clean suburban service in order to induce more people to live in the suburbs and thus assist in the development of Bombay by relieving the congestion in the city.

Economy in operation, combined with increasing the terminal facilities of Victoria Terminus without very great expenditure was also another consideration, while the rapid handling of freight trains over the Ghauts is a fact which will be manifest when the sections to Lonavla and Igatpuri are electrified.

At the present time the Harbour Branch Line is the only section operating electrically, though construction work on the other suburban sections between Bombay and Thana is being pushed on rapidly.

Electric power for the operation of the railway is purchased from the Hydro-Electric Power Companies operated by Messrs. Tata & Sons. This power is supplied from the Hydro-Electric Company's Receiving Station at Dharavi at a pressure of 22,000 volts, and is conveyed by means of underground cables to the Railway sub-stations situated at Wadi Bunder and Kurla. Similar sub-stations will be situated at Thana and Kalyan to serve the other suburban sections of the line.

The power at 22,000 volts is received at the sub-stations on a heavy armour clad switchboard, whence it is distributed to various static transformers which transform the power down to suitable pressures for conversion and transmission.

The bulk of the power thus transformed is applied to the rotary converters.

These rotary converter sets consist of two machines each of 2,500 K. W. capacity, the output from each machine being Direct Current at 750 volts. The two machines are connected in series to supply the required 1,500 volts for the operation of the trains. A small portion of the power is transformed down to 2,200 volts three phase and distributed by means of a transmission line carried on the traction structures for station lighting, etc. The 1,500 volt direct current power is supplied through feeders equipped with automatic overload switches which open in the event of a short circuit on the system.

The system of power supply to the trains is of the overhead line type.

The overhead line construction adopted is of the simple catenary type in which a copper catenary cable of .375 square inch area is supported on suitable porcelain insulators on steel structures spanning the tracks.

From this catenary cable is suspended the copper contact wire of grooved section .25 square inch in area by means of dropper wires. This suspension is rendered flexible by the introduction of a small length of chain in each dropper.

The wires are erected in lengths of approximately 4,000 feet. The easy passage of the bow collector on the train from one section to another being effected by means of an overlap span. The power is collected from the line by bow collectors on the roof of the trains, these collectors are operated by vacuum.

The trains each consist of four coaches, one of which is equipped with the driving motors and their attendant switchgear. It is possible to connect two or more such units together to operate as one train to traffic requirements.

The electrical equipment of the trains consists of four 275 B.H.P. motors each of 750 volts coupled permanently in two groups of two motors on series.

The motors are controlled by a camshaft gear, which in addition to providing rheostatic control, performs the necessary switching operation for series-parallel control of the motor groups.

The movement of the camshaft gear is effected by means of direct current power at 120 volts controlled from the driving position by a small Master controller operated by the driver. This control power is supplied by a small motor generator on the train.

The brakes are operated on the standard automatic vacuum system, vacuum being created by a motor driven exhauster.

The current after passing through the motors completes the circuit *via* the running rails which are suitably bonded at the joints by means of copper bonds pressed into the rails under the fish plates.

The Electric service on the Harbour Branch Line was inaugurated by H. E. The Governor of Bombay on the 3rd February 1925, and though a certain amount of trouble was experienced due to minor adjustments in the equipment and from the Indian Crow building his nests near the live line wires, is now operating successfully and has come to be regarded as one of the everyday necessities of life in Bombay.

* THE LIGHTFOOT REFRIGERATION CO., LTD.

The Ice and Oxygen Factories of this Company are situated at the end of Hansraj Lane adjacent to Byculla Bridge. This site was selected for its central position for supplying both Ice and Oxygen to all parts of the city. The land was acquired in May 1912, and building operations were commenced immediately, Ice being produced early in 1913.

ICE FACTORY.

The original Ice-making Plant was capable of producing 60 tons of Plate Ice daily, but this Plant was found to be insufficient, and the capacity was increased to 150 tons per day by the addition of two separate Can Ice units.

The original Plant was driven by Diesel Oil Engines, but in view of extensions, these were replaced by electrically driven motors with power from the Tata Hydro-Electric & Power Co., Ltd.

The Refrigerating Plant consists of horizontal Ammonia Compressors working on the special "Lightfoot" system for economical Ice production in tropical climates.

The Ice Plant is the largest and most up-to-date installation in India. Provision has been made for further extensions when necessary, sufficient space being available to duplicate the Plant. Recently a plot of ground adjacent to our existing site was purchased for the purpose of providing another entrance to our Factories, and also for the construction of Cold Storage accommodation, etc.

OXYGEN FACTORY.

The Lightfoot Company commenced the manufacture of Oxygen Gas in India, for commercial purposes, in the first place at Calcutta, but as it was impossible to supply Bombay's requirements from this source, a Plant was installed in this city in 1914, and an extension Plant was put in 1920.

Oxygen Gas is produced by the Liquid Air Process and compressed into solid drawn steel cylinders which comply with all Home and Indian regulations, etc., being also annealed and tested at regular intervals. The Oxygen Plants are electrically driven.

To demonstrate the uses of Oxygen in connection with Welding and cutting work a special staff of Welders is maintained. Oxy-Acetylene welding or cutting work is also executed, and suitable men are trained for clients who purchase welding or cutting plants, etc.

Liquid Oxygen is available for research work or for use as an explosive, and special containers are available for the transport of Liquid Oxygen for these purposes.

EXCURSIONS.

Bandra.—Bandra is situated on a promontory in the south-west corner of the island of Salsette and lies a little beyond Mahim to which it is connected by the Lady Jamsétji Causeway (See Map). Bandra Hill and the adjoining Pali Hill, where there are Golf links are favourite places of resort for the citizens of Bombay, and can be reached either by a motor car through the Mahim Woods or by train to Bandra Station on the B. B. & C. I. Railway. Hack victorias can be obtained at Bandra Station. Near the railway station and the north end of the Causeway is the Bombay Municipal Slaughter House. In the days of the Portuguese, the Jesuit College of St. Anne stood upon the spot and it was described as “not inferior as to the building nor much unlike those of our Universities of Oxford and Cambridge.” The road to Bandra divides at the foot of the hill and here near the seaside is the Church of St. Andrew built by the Jesuits in 1570. A large Cross stands in the compound of this church, and it is said that it originally belonged to the Church of St. Anne. On the top of Bandra Hill is the Church of the Lady of the Mount, conspicuous by its two high spires; close by is the English Church, St. Stephens. At the extreme point of Bandra are the ruins of an old block-house erected by the Portuguese in 1640.

Elephanta.—This is an island in the harbour about 6 miles to the east of Bombay and about 4 miles from the mainland of Konkan. It is called Elephanta, because near the former landing place on the south side of the island stood, in olden times, a large stone elephant. “Pyke in 1812 and Anquetil du Perron in 1760 represented the elephant as having another smaller one on its back. In 1764 Niebuhr reported that there were remains of something on the back but that it was impossible to distinguish what it was.” Basil Hall conjectured that the “smaller animal” was a tiger. It is, however, most probable that it was an “*Ambari*” or a canopied howdah. “In 1814 the head and neck of the elephant dropped off and the body which had a large crack down the back sank down.” It eventually fell to pieces. “Sometime about 1864 the Government of Bombay entrusted the conservation of the caves to an official of the Public Works Department, an Engineer, with whom as with engineers universally, ‘Nothing is sacred’ who forthwith proposed to clear out this profoundly interesting heap of stones and break them up into road metal.” The broken pieces however were brought to Bombay through the exertions of Sir George Birdwood and deposited in the Victoria Gardens, where they remained as a shapeless mass for a long time. Recently these pieces have been put together, and the “restored” elephant now stands again near the Victoria and Albert Museum, minus however the “something” on the back. Old travellers

also state that at a little distance from the elephant, where the two hills approach each other, stood a stone horse, which an early writer described as being "so lively, with such a colour and carriage and the shape finish with that exactness that many have rather fancied it; at a distance a living animal than only a bare representation." When Freyer saw it in 1673 it "had sunk into the earth up to the belly." Alexander Hamilton saw it there in 1718 but thought it was "not so proportionable or well-shaped as the elephant." It had disappeared by 1784.

The local name for Elephanta is "Gharapuri" said to be a corruption of Mangalapuri, the headquarters of the Maurya Dynasty. Traces of this city are still to be found near the northern landing place in the form of broken pillars, brick and stone foundations and fallen statues of Shiva.

The modern landing pier is at the north-west side of the island; the paved ascent which leads from it to the caves was constructed by Karamsi Ranmal, a Lohana merchant of Bombay, in 1853.

The caves which are of Brahmanical origin are dedicated to Shiva; they are situated at an elevation of about 250 feet above the high-water level and are entirely hewn out of a hard compact variety of trap rock. The whole excavation consists of three parts; a central temple or the Great Cave, with a smaller chapel on each side. The Great Cave measures about 130 feet from side to side and is of about the same size from front to back. The flat roof was originally supported by 26 carved columns with 16 half columns, but many of these pillars have been either injured or destroyed. The west side of the cave is occupied by the Shrine proper and the various compartments of walls between the pillars are carved with sculptures representing scenes from the Hindu Mythology.

The Shrine is a square chapel with four doors and contains the *Linga* which represents "Shiva in his character of the prolific power of nature." Around this *linga* chapel are a number of large figures representing Dwarapalas or door-keepers. Of the various sculptures on the walls the most striking is the colossal "Trimurti;" it is situated at the back of the cave and faces the entrance. It represents Shiva in his three-fold character: Brahma, the Creator occupies the centre of the figure; Vishnu, the preserver is to his left holding a full-blown lotus in his hand; and Rudra, the destroyer to his right, holding a cobra. "In 1865 this unique bust was destroyed by some barbarian clothed in the garb of civilization, who broke off a portion of the noses of two of the faces; and since then some of the other sculptures in the temple have been similarly treated, so that it has been found necessary to place a Sergeant and two native policemen to guard the cave."

The other sculptures represent "Ardhanarishwara," or Shiva as uniting the two sexes in his person; Shiva and Parvati;

Mount Kailasa, Ravana shaking Mount Kailasa ; Tandava Dance ; Bhairava ; and Shiva as an Ascetic.

Of the two small chapels at the sides, the one to the east contains a small "Linga" with steps leading to it guarded by two sculptured lions ; while the small chapel to the west contains a reservoir for water and is also dedicated to Shiva. There are also other caves in the neighbourhood ; but they are in a more or less dilapidated condition.

No data are available for fixing the precise date of excavation of these caves. An inscription stone which existed over the entrance was removed about the year 1540 by Dom Joao de Castro, the Viceroy, and sent to D. John III, King of Portugal ; but no one now knows what has become of this valuable relic.

The flora of Elephanta is practically the same as that of the jungles of Salsette. As regards the fauna, Hamilton (1718) states that when he fired a gun in one of the caves "a serpent 15 feet long and two foot about gave him chase and made him take to his heels," but no such denizens are met with there now. The golden or tortoise beetle (*Aspidomorpha sanctæ-crucis*) and the green bug, *Chrysocoris stockerus* are common on the island.

Kanheri (Kennery) Caves.—These caves are situated in a wild and picturesque valley in the heart of the island of Salsette and may be reached from Borivli Station on the B. B. & C. I. Railway from which there is a tonga road to within a mile of the caves. The name Kanheri is a corruption of "Kanhagiri" which in turn is a Prakrit corruption of Krishnagiri, *i.e.*, Krishna's Hill, and it is conjectured from this that the fame of the hills for sanctity must have dated from before the rise of Buddhism.

The caves are Buddhistic and number over one hundred. An inscription in the caves at Nasik has led archæologists to suppose that they were constructed between 100 B. C. and 50 A. D.; but apparently some fresh caves were excavated subsequently, during the fourth, fifth and sixth centuries. Bishop Heber has remarked that "the beautiful situation of these caves, their elegant carving and their marked connection with Buddha and his religion render them every way remarkable." The caves consist of numerous dwellings for Buddhist monks, and some "Chaityas" or relic-shrines. Of the latter the large "Chaitya cave," sometimes also called the "Cathedral cave," is the most important. In front of it once stood three relic mounds which Fergusson thought were more ancient than the cave itself. They were probably the chief objects of veneration, and the great cave was subsequently excavated near them by some devotees. The largest of these mounds was between twelve and sixteen feet in height, and built of stone and brick. Dr. Bird opened it in 1839 and found therein two copper-plates

and "a circular stone hollow in the centre and covered at the top by a piece of gypsum." The copper-plates had the Buddhist creed inscribed thereon, while the stone coffer contained two small copper urns in one of which were ashes with a ruby, a pearl and a small piece of gold; there was also a small gold box containing a piece of cloth. The other urn contained a silver box and ashes. The vestibule of the great cave contains two gigantic figures of Buddha 23 feet high. The next important cave is the "Durbar Cave", distinguished by "two long low seats or benches running down the whole length of the centre." It was a place of assembly and a hall of audience. The "Vihars" or the Monks' dwelling caves are scattered all over the hill in the neighbourhood at different levels, and the remains of an old dam which at one time formed a large reservoir are still visible. These caves did not escape the religious zeal of the Portuguese. About the year 1535 Fr. Antonio, a Franciscan friar, forcibly converted the Buddhist ascetics and "turned the great *Chaitya* cave into a Christian Church of St. Michael and it was used as such until after the fall of Bassein." Anquetil du Perron states that it was still used by the Christians in 1760.

Vehar and Tulsi Lakes.—These can be got at most easily by a motor car *via* Vincent Road. This road passes through Sion village and near Sion Railway Station joins an excellent new road running along the west side of the G. I. P. Railway line. The old Duncan's causeway which passes through the narrow and crowded Kurla Bazaar should be avoided. The new road, however, has its drawbacks. Beyond Kurla the road passes through a hilly district. The Powai lake lies to the right and the road to it passes through an old gateway; Vehar Lake lies further north. The leakage water from these lakes was at one time utilised for the cultivation of *Agave americana* on a large scale, but owing to prevalence of malaria among the plantation labourers, the project had to be given up. The last portion of the road to Vehar goes up a stiff hill. A monument just within the entrance gate records the services of Captain Crawford who was the author of the Vehar Water-works scheme; at the other end of the embankment is a small Dak bungalow owned by the Bombay Municipality. To the north of Vehar is the lake of Tulsi; and further north still among the hills lie the caves of Kanheri. The Vehar and Tulsi lakes yield a daily supply of $9\frac{1}{2}$ and $4\frac{1}{2}$ million gallons of water respectively. The return journey may be made through Pawai grounds. The scenery near this lake, especially during the monsoon is extremely pretty; the road through the Pawai estate runs by the side of the lake and ultimately joins the Thana-Kurla road.

Ghodbundar and Thana.—This excursion is interesting from an archæological as well as an artistic point of view, and should

be made in a motor car through Mahim. In the southern part of the Mahim Woods stands the Hindoo temple of *Prabhadevi*, the family goddess of Raja Bimb of Mahim. The original temple was destroyed when Mahim was taken by the Mahomedans, but was re-built in 1714. Further north among the palm trees stands the Roman Catholic Church of *N. S. da Salvação*, and at the end of the Lady Jamsetji road near the causeway, to the right, lies the church of *San Miguel*. These two Churches belong to the period when this part of the island was given by the Portuguese Government free of rent to the various Roman Catholic religious orders. On the opposite side of the road stands the old *Mahim Fort* and a little to the south of it is the fifteenth century *Shrine* of the Muhammadan Pir Sheikh Makhtum Shah. After the creek is crossed to the right will be seen the *Slaughter House* where once stood the Jesuit College of St. Anne; further on is the *Bandra Station*. The road next passes through *Santa Cruz*, *Ville Parle*, and *Andheri*; these places have only lately become studded with little villas, chiefly built by the citizens of Bombay since the days of plague. A little beyond Andheri to the right is the *Jogeshwari Cave* which is the third largest Brahmanical cave in India, being 240 feet long and 200 feet broad. It dates from the 7th century and "contains rock cut passages, an immense central hall supported by pillars, porticos and subsidiary courts." The road then passes on to *Borivli* which is "a convenient centre for visiting the several places of interest which exist in this neighbourhood." The *Kanheri Caves* lie up the *Tulsi valley* about 5 miles to the east. At *Mandapeshwar*, called *Mompezier* or *Mompacer* by the Portuguese, about a mile to the north of *Borivli*, are situated a notable white Portuguese tower and a set of Brahmanic caves over a thousand years old, one of the latter being specially interesting from having been used as a Catholic Chapel. On the top of the rock in which the caves are cut stands a large and high-roofed Portuguese Cathedral, lately repaired, and extensive ruined buildings, belonging to a college and monastery. In a Mango-orchard called *Maniparla wadi* at *Eksar* in rich wooded country, about a mile north-west of *Borivli* are some great blocks of stone about 10 feet high by 3 feet broad. They are memorial stones richly carved with belts of small figures, the record of sea and land fights probably of the eleventh and twelfth centuries. About half a mile to the east of *Borivli* station close to the border lands of *Poinsar*, and the deserted village of *Magathan*, are some Buddhist rock-cut cisterns and some half-underground Buddhist caves. A few hundred yards to the east lie some Buddhist tombs and the remains of a Buddhist monastery, probably of the fifth or sixth century. At *Akurla* about 2 miles to the south-east, in rugged bush land rises a large mound of black trap, on the top of which are

some quaint rough carvings and Pali letters perhaps two thousand years old."

After crossing the B. B. & C. I. Railway line at Borivli station the road goes northward until it reaches *Ghodbundar* which is supposed to be the Hippokura of Ptolemy. There is a good district bungalow situated on the top of a hillock, and reached by a conspicuous flight of steps; it was at one time a Roman Catholic Church but previously, probably a mosque; a Muhammadan Pir's grave is seen quite close to the parapet. A magnificent view of the surrounding district can be had from the bungalow. To the north lies the Bassein creek with the Tungar Hill beyond; this scenery has been sometimes compared to the Scotch Lakes. The Tungar Hill which is 2,200 feet high and covered with a thick forest, is likely to prove a very desirable site for a Sanatorium on account of its openness to the sea-breezes and its comparatively light rainfall. To the west can be seen the long railway bridge over the Bassein Creek, and further west a faint glimpse can be had of the ruined spires of the old Portuguese Churches of Bassein. Near the district bungalow itself are ruins of a large monastery and College. During the days of the Portuguese, *Ghodbundar* with the surrounding district was the property of Martin Alphonso said to be "the richest Don on this side of Goa." The road from *Ghodbundar* to *Thana* runs along the south side of the creek through a hilly district with pretty scenery and passes by a ruined square building which was the banqueting-house of John de Melos. His mansion stood close by "on a sloping eminence decorated with terraced walks and gardens." As the road approaches *Thana*, the surrounding country becomes flat and uninteresting. *Thana* was a very important city in the thirteenth century; it was the capital of a great kingdom with an independent Hindu ruler. In 1318 it was conquered by the Muhammadans, and here in 1320 four Roman Catholic priests suffered death for their religion at the hands of the new rulers. The names of these martyrs were: Thomas of Tolentino, James of Padua, Peter of Siena, and Demetrius, a lay brother. In 1534 *Thana* was finally made over by the Muhammadans to the Portuguese, under whose rule it again became prosperous; its Roman Catholic Cathedral belongs to that period. In 1737 *Thana* was taken by the Marathas and with the fall of Bassein in 1739 the whole of Salsette became their property. In 1774 *Thana* was stormed by the English and "almost all the garrison were put to the sword," and with the treaty of Salbai in 1782 it finally passed into their hands. In 1816 the Peshwa's Minister Trimbakji Denglia was imprisoned in the fort of *Thana*, but effected his escape although he was guarded by a strong body of European troops. The story of his escape is as follows:—A horsekeeper in the service of one of the English officers of the

garrison managed to convey to the prisoner the information, that friends with a horse were waiting outside. He did this by singing the information to his master's horse while exercising the animal under the window of Trimbakji's cell. The language of the song was unknown to the English who therefore did not notice the ruse. Bishop Heber who had seen Trimbakji before, was much interested in his escape, and has translated the groom's song into English verse as follows:—

“ Behind the bush the bowmen hide,
 The horse beneath the tree ;
 Where shall I find a knight will ride,
 The jungle paths with me ?
 There are five-and-fifty coursers there,
 And four-and-fifty men ;
 When the fifty-fifth shall mount his steed,
 The Deckan thrives again.”

The fort is now used as a jail. In 1825 Bishop Heber himself consecrated the little English Church at Thana. There is a good Travellers' Bungalow and the return journey to Bombay may be made *via* Bhandup and Kurla.

Bassein.—Bassein lies about 28 miles north of Bombay and was in the time of the Portuguese a very important and rich city and although it is now in ruins an idea of its past greatness can be obtained even in these days from the ruined churches, monasteries and other buildings which are well worth a visit. It can be reached by B. B. & C. I. Railway and lies about 5 miles to the south-west of Bassein Road Station where tongas are usually available.

Bassein appears to have attracted the notice of the Portuguese from very early days and was ceded to them by Bahadurshah, King of Gujarat, in 1534. The Portuguese promptly fortified the place, established themselves firmly there and raised it to such prosperity that it came to be known as the Portuguese Court of the North. Wealthy noblemen adorned the city with a cathedral, five convents, thirteen churches and an asylum for orphans. Only the *Hidalgos* or Aristocracy were allowed to dwell within the city-walls in “ stately buildings two storeys high and graced with covered balconies and large windows.” For over two centuries the Portuguese remained masters of Bassein but in 1739 Chimnaji Appa, a celebrated Maratha General, appeared before the city with a powerful army and after a siege of three months forced the garrison to capitulate. Bassein thus passed into the hands of the Marathas. In 1780 it was captured by the British, but was restored to the Marathas by the treaty of Salbai. In 1818, however, with the overthrow of the last of the Peshwas it was resumed by the British and incorporated with Thana District.

The old ramparts still remain in a fair state of preservation but the buildings within the walls are in ruins ; yet the cathedral and the various churches can still be made out. The following is a short account of the ruins of Bassein, kindly supplied by Miss Cates :—

Beginning from the sea-side the first object of interest is the massive double sea gateway with its well preserved teak and iron doors, one of which bears, partly hidden by an iron bar, the date "20th November 1720." Within the gate on the left is a small temple of Hanuman. On the same side is seen a building with a massive high tower and walls overgrown with trees : this is the Cathedral or Matriz of St. Joseph. The door bears the following inscription in Portuguese cut in stone : " In the year 1601 when the most illustrious Sgr. Dom Frei Aleixode Menezes was Archbishop Primate and the Revd. Pedro Galvao Pereira was Vicar, this Cathedral was rebuilt." The towered front and the side walls with arched doorways and lancet windows are in fair repair, but the roof is gone and the steps up the tower are decayed. On a black oblong tombstone in the chancel to the right of the main altar is the following inscription : " To this grave are transferred the bones of Pedro Galvao, a servant in the Lord, who managed and enlarged this church. He died at Goa on 19th March 1618." At the west end of the nave a half-buried tomb bears the name, " Antonio de Almeida de Sampaioe." The cathedral seems to stand on the site of the church of St. Joseph which was built in 1546. A plain arched passage between the cathedral and a private house to the right is perhaps a relic of the dislike the wives of the noblemen of old Bassein had to be stared at on their way to church. The open space at the end of the street to the left of the sea-gate is a great square or market ; and around it are the remains of what were once fine buildings. One of chief of these was the State House where in 1675 the Governor convocated " the nobles every morning upon consultation " and where they all stood, a chair not being allowed even the Governor though gouty. The ruined doorway beyond the market belongs to the Castle or Round Citadel. On either side of the door were two pillars of which only the Corinthian capitals are left. Above are a Maltese cross, a coat of arms, a sphere and the date 1606. Inside the gate the whole space is strewn with ruins. To the left along a path choked with shrubs and fallen stones are the ruins of a bastion with the oldest inscription in Bassein : " The first Captain who built this fortress was Garcia da Sa by command of the Governor Nuno da Cunha in the year 1536." These ruins are said to have been older than the Portuguese and to have been the residences of the Muhammadans to whom the place previously belonged. Further back, heaps of rubbish and one or two doored and windowed walls are all that remain of the palaces

of the General of the North and of the Captain of Bassein. A little behind the gate of the Round Citadel and near the end of the street that leads from the sea-gate along the wall are the ruins of a very large building supposed to be the house of the Captain or the Court of Justice, but more probably the Church and Convent of the Augustines. The portico which is approached by a flight of five deep steps is supported by four pillars which divide the entrance into three arches leading into the vestibule. In the back-ground are the Portuguese Royal Arms and some worn-out devices. Two inscribed stones have fallen, one from the architrave and the other from the tympanum. The writing on the architrave runs as follows: "This portal was built during the government of the Viceroy Dom Miguel de Noronha, Count of Liuhares and on it St. Francis Xavier was placed as patron of the city, 10-5-1631." The inscription on the tympanum runs thus: "When Gaspar de Mello de Miranda was Captain of the city and Goncalo and a few other officers were aldermen, this portal, which took St. Xavier as its patron was built in the year 1631." Next to the palace are the ruins of the Factory, the residence of the Factor who was second in rank to the Captain; close by are the ruins of a very large building apparently a granary. Separated from the palace of the General of the North by the large oblong space of the old palace garden are the Church and Hospital of Pity. The Hospital which faces the wall on the river side is a long massive pile with a large square courtyard surrounded by a beautiful cloistered arcade. It was a very old institution and was endowed by the Portuguese Government. The Church though small had a handsome front of finely dressed stone and delicately wrought pillars. Above the doors is a stone escutcheon with a beautiful Maltese cross in the centre and on either side a dragon with a roll in its mouth. Inside the church are two tombstones, the larger one with the inscription: "The grave of P. Cabral de Navais and of his son P. Hieromino P. Cabral and his heirs"; the other stone has only a few letters. Not far from the entrance of this church is a modern Hindu temple of Mahadeo, and parallel to it is the Church of Nossa Senhora da Vida which is one of the oldest churches in Bassein. In a grave opened when digging the foundations of a Sugar Refinery were found the bones of a man and horse evidently buried together. A little beyond, in the front of the square, are the ruins of the Church and Monastery of the Jesuits. The Church front, with its Corinthian capitals, the monogram I. H. S. and a cross sculptured on the lintel above the pillars, is acknowledged to be the handsomest piece of architecture in Bassein. Attached to the Church are the ruins of a College, which although overgrown with creepers and trees, are still firm and in good condition; the date over the door is 1636. The foundations of this church and monastery were laid in

1548 by M. Malchior Gonsalves, a close friend of St. Francis Xavier. In the nave of the church near the chancel are two grave-stones, one with the following inscription: "The grave of Isabel de Aguiar, a widow lady, the noble helper of this College. Died on the 24th January 1591." The other inscription runs thus: "The grave of Donna Filipa da Fonseca, a widow lady, the noble helper of this church, to which she gave during her lifetime all she possessed. She died on the 20th July 1628." A little beyond the ruins of the Jesuit buildings is the Franciscan Church of the Invocation of Santo Antonio, the oldest and one of the largest religious buildings in Bassein. The arched ceiling of the chief chapel with elaborate mouldings is fairly preserved. Unlike most Bassein buildings the Franciscan church is of dressed stone and has basalt in its staircases, arches, windows and door-posts; one staircase is still in good condition. There was a Monastery as well as a Church, and the ruins of both can still be traced. Among the tombstones in the nave and chancel one has the following inscription: "The tomb of His Majesty's Councillor who died on 24th August 1558 and his wife Donna Luiza da Silva and his heirs." To the right of these Franciscan ruins, and almost between them and those of the church and monastery of the Jesuits, are the ruins of the Dominican Church and Monastery built in 1583. The walls and tower of this church and a little of the peaked roof near the chancel are still standing in good order. On the Gospel side of the altar is the ruined tomb of the patron with a scarcely legible epitaph. The road between the Dominican and Franciscan ruins and the fort-walls leads to the Bastion of San Sebastian with a blocked postern. The inscription stone lies neglected near the land gateway and has the following words: "King Dom Joam of Portugal, the third of his name and when D. Afonso de Noronha, son of the Marquis of Villa Real was Viceroy, and Francisco de Sa, Captain of the Fort and City of Bassai, this bastion named San Sebastian was built on 22nd February 1554." A few yards from the bastion is a modern English tomb with the following words: "Here lies the body of Jane Durham, wife of Andrew Durham, Surgeon, who departed this life in 1776." On the other side of the wall leading from the postern are the ruins of the pier. Inside the wall a passage is said to run to the river, but as the air is bad and puts out lights, this passage has never been explored. On both sides of an old street, nearly parallel to the new high road which runs along the middle of the fort to the sea-gate are the remains of the old stately dwellings of the Hidalgos "graced with covered balconies and large latticed or oyster-shell windows." Near these old mansions in a square overlooking the road are the ruins of the Augustine Chapel of Nossa Senhora de Annunciada. The front is double-arched, the walls and side windows of the

chancel are well preserved and parts of a vaulted roof with painted mouldings are still visible.

**Alibag*, north latitude $18^{\circ} 39''$ and east longitude $72^{\circ} 57''$ is the head-quarters of the Kolaba district. The town lies on the coast, nineteen miles south of Bombay, at the mouth of a tidal creek, locally known as Sakhar creek. The view of Alibag, as it is approached from the sea, is exceedingly picturesque. In the fore-ground is the sea-fort of Kolaba, with its temples, ruined palaces and trees, beyond is the long line of palms broken only by groups of still higher casuarinas. The town itself is almost hidden. About two miles out at sea, to the south-west of the Kolaba fort, a round tower about sixty feet high, marks the Cheul Kadu, a dangerous reef covered at high water on which many a ship has been wrecked.

The section of the Bombay Observatory consisting of sets of instruments for magnetic records, both for automatic registration as well as for direct observation, is housed in a group of specially constructed buildings at Alibag. The officer, who is in charge of the Meteorological and Seismological Observatory at Colaba, is also in charge of the magnetic section at Alibag.

A special excursion is arranged to visit this place in connection with the meeting of the Indian Science Congress.

**Ambarnath* is a small village about four miles south-east of Kalyan. It gets its name from a shrine of the god Ambarnath or Ambareshwar, about a thousand yards east of the village over which about the middle of the eleventh century a very rich temple was built. The temple is situated on the left bank of a tributary of the Valdhan river and is built in the many-cornered Chalukya or Hemadpanti style. Considerable artistic work is to be seen inside the temple as well as outside.

Recently the place is becoming famous as the future industrial area for the city of Bombay. The Dharamsi Morarji Chemical Works are situated here and a special excursion to that place is arranged for the members of the Indian Science Congress.

**Jogeshwari or Amboli Caves*, in Salsette, about two and a half miles south-east of Goregaon, to the north of Bombay, is a very large, once richly ornamented, now decayed Brahmanic temple of the eighth century. It is cut in a low dome of crumbling volcanic breccia in the waving palm-covered uplands that rise between the outer belt of rice-fields and the central Vehar hills. In point of rich carving and a variety of figures and architecture, next to the Kailasa at Elura this is the largest known cave in India. Its length from east to west is 240 feet, or including the two rock-cut passages 320 feet; and its breadth including the long passage in the south, is 200 feet. According to Dr. Burgess it has the special architectural interest of showing almost no trace of the arrangements of a Buddhist monastery. Its large

porticos and courts point to the development of the style that appears in the built temples of Ambarnath near Kalyan (1060), of Pattan Somnath in south Kathiawar (1198), and of the Abu temples in north Gujarat (1197-1247). It may be roughly stated that if the Dumar cave at Elura were cut in the first quarter of the eighth century, the great Elephanta cave very soon after, then this Jogeshwari cave should date from the latter half of the eighth century.

* *Khopoli*, formerly known as Campoli is a small village on the Poona-Panvel high road five miles south-east of Khalapur. Khopoli is at the foot of the Bor Ghaut incline about 1,600 feet below Khandala on the crest of the Sahyadris. The place can be reached by a special branch Railway line from Karjat, which is a station half-way between Bombay and Poona. The first of the Tata hydro-electric installations is at Khopoli and a special excursion is arranged to visit this place in connection with the meeting of the Indian Science Congress.

* POONA.

THE chief centre of education in Maharashtra, has several unique features. It is a town of about 150,000 inhabitants, and is situated on the banks of the rivers Mula and Mutha. It is the seat of the Government for about five months in the year. It has three Arts Colleges, an Agricultural College, an Engineering College, a Law College, several High Schools, among which are two of the biggest High Schools in the Presidency, a Medical School, a Women's University and various other educational institutions.

The Deccan College, one of the first Colleges to be established in this Presidency, was affiliated to the Bombay University in 1860. It is situated on the left bank of the Mula at a distance of about 3 miles from the city, most of the students living in the Quarters near the college.

The Engineering College, developed out of the Poona Civil Engineering College, and was affiliated to the University in 1865. The College has well-equipped Laboratories and Workshops for training students in Civil and Mechanical Engineering, and the Electrical side is also going to be developed in the near future.

The College of Agriculture, is a development of the Agricultural Classes held at the old College of Science since 1878. It was affiliated to the University in 1907 after the Institution of the degree of L.Ag. It has excellent arrangements for giving practical instruction to students in subjects like Farming, Horticulture, Gardening, etc., and also Laboratories for Physics, Chemistry, Botany and other allied subjects. Up-to-date *Dairy and Breeding Farms* are also attached to the College where students obtain practical experience.

The Fergusson College, is conducted by the Deccan Education Society, which was founded in 1880. It is the largest College outside Bombay and is affiliated for the Faculties of Arts and Science. It has large laboratories for Chemistry, Physics and Biology and also possesses a fine Library, the nucleus of which was presented by the late Mr. V. N. Mandlik. The newly started *Law College* at present meets in the buildings of this College, for want of separate accommodation.

The Bhandarkar Oriental Research Institute was founded 10 years ago to commemorate the work of the late Sir R. G. Bhandarkar. It possesses a very valuable collection of ancient manuscripts and palm leaves which are accommodated in a specially built fire-proof hall.

The Indian Womens' University, is the natural development of the Hindu Widows' Home, founded by Prof. D. K. Karve. The two unique features of this University are the use of the vernacular as the medium of instruction, and the adoption of special courses suited to the needs of women. The University conducts a High School and a College in Poona, and has half a dozen other Institutions affiliated to it in different places in the Presidency. Attached to this institution is a small precision Workshop where some excellent physical apparatus is prepared according to individual requirements or to meet larger orders from College Laboratories.

The Ranade Industrial and Economic Institute, founded by the late Mr. G. K. Gokhale in memory of Mr. Justice Ranade, aims at helping industrial concerns in solving their chemical problems and also at conducting original investigations.

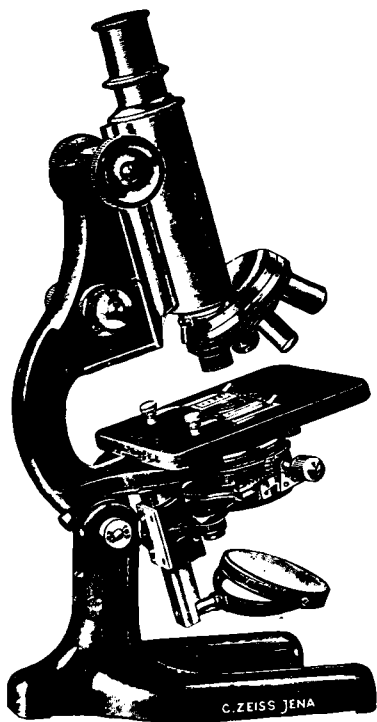
The New Poona College, conducted by the Shikshana Prasarak Mandali, was founded in 1916 and is affiliated to the University for the purposes of the Faculty of Arts.

Bharat Itihasa-Sanshodhaka Mandal, a society for conducting research in Indian history, has done very valuable work in recent years in throwing light on many problems, especially in Maratha history. It has a very valuable collection of historical documents, and its journal is one of the most important organs for the publication of historical papers.

In addition to all these institutions, Poona possesses many other attractions, some of which are, the Parvati and Chaturshringi temples, the Shanwar wada (palace of the Peshwas), the Empress Gardens, the B. J. Medical School, the High School for Indian Girls, the various institutions conducted by the Seva Sadan Society, and several Primary and Higher Schools.

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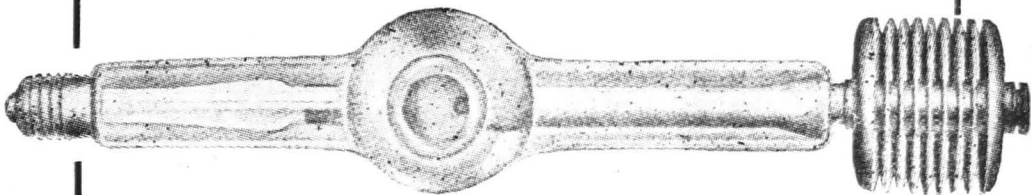
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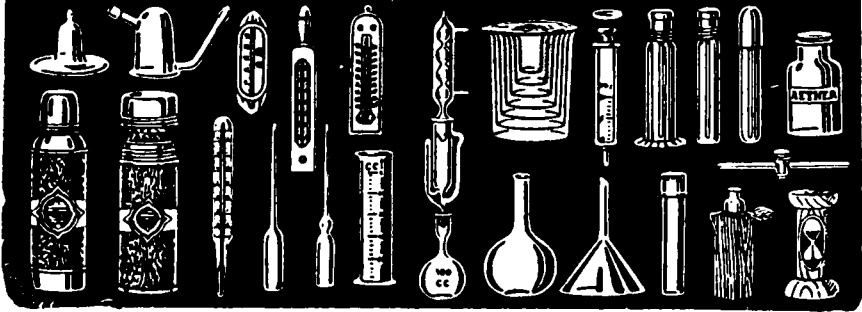


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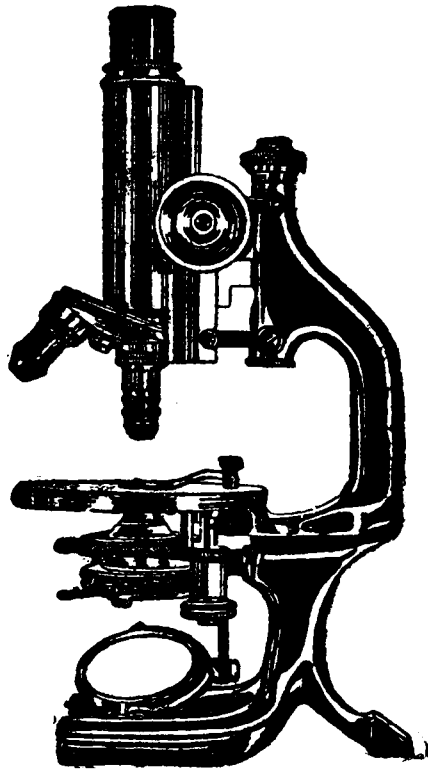
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