observing station with intermediate velocities through the basaltic layer (about 20 Km. thick). The importance of the recognition of these six phases and also of the reflected primary and the secondary waves for a correct diagnosis of seismograms of near earthquakes cannot be over-emphasised. The phases P_M, $\bar{P}_M$, S_M and $\bar{S}_M$ appear to be identifiable on the seismograms of Calcutta and Agra (Figs. 1 and 2). The reflected waves are also traceable on some of the Indian seismograms (Figs. 2, 4 and 5) but the phases P_M* and S_M* are either absent or difficult to trace. One is naturally tempted to suggest that the phase P_m marked on the Calcutta seismogram may be taken as P_M and the phase marked P_M identified as P_M* but the feeble nature of the movements of P_m and other characteristics of the Calcutta seismogram do not appear to support such an explanation.

The arrival-times of the important phases based on the present identification are tabulated at the top of Fig. 6. The origin time of the major shock as obtained by plotting $(S_M—P_M)$ interval against the arrival time P_M is 8 h. 43 m. 22 s. G.M.T. The epicentre is located near Lat. 26·6° N., Long. 86·2° E. in agreement with the following epicentral distances:—Calcutta 493 Kms., Agra 805 Kms., Dehra Dun 902 Kms., Bombay 1,610 Kms., Mangalore 1,929 Kms., and Kodaikanal 2,026 Kms. The time-distance curves of the important phases of the principal shock are also given in Fig. 6. The development of surface waves (Fig. 3) and the general trend of the time-distance curves of the various phases suggest that the focal region of the principal shock was of shallow depth, but a reliable estimate of the actual depth from the seismograms is not possible in the absence of records close to the epicentre.

The main object of the present note is to point out that a preliminary examination of the available Indian seismograms does not suggest that the focal region of the principal shock of January 15 was very abnormal in extent. A detailed discussion of the seismograms of the principal shock and its aftershocks will be published elsewhere.

Some Foreign Weeds and their Distribution in India and Burma.

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MR. A. C. JOSHI'S note on the occurrence of *Croton sparsiflorus* in the United Provinces, published in *Current Science*, **2**, 344, 1934,[6] prompts me to put down my observations regarding the distribution of some of the common harmful exotic weeds established in this country.

The interesting study of migration of foreign plants dates from a very early period, as far back as 1786, the date of the foundation of the Royal Botanic Garden, Calcutta (the then Hon. East India Company's Botanical Garden, Calcutta) and the Serampur Botanical Garden—generally known as Dr. Carey's Garden. During this time Roxburgh, "the father of Indian Botany", and Dr. Carey of great fame started cultivating in their gardens at Sibpur and Serampur, various species of foreign and indigenous plants with a view to have a suitable botanical garden of scientific value near Calcutta. This work was followed by such eminent botanists as Voigt, Wallich, Griffith, Buchanan, Hamilton, Falconer, Thomson, Anderson, Clarke, King, Gamble and Prain. Thus by the time Brühl published his *Recent Plant Immigrants* in 1908,[3] the Botanic Garden at Sibpur during the course of one hundred and twenty-two years, formed a centre of distribution of a large percentage of plants at present found in the neighbourhood of Calcutta in the district of Hooghi-Howrah and the 24 Parganas. Coastal invasion of foreign plants either by sea or by ships calling at the various ports of this country may be considered another source of migration of foreign plants. Exchange relation in plants with different gardens and introduction of seeds by private individuals may be other important factors of local migration of plants. The problem of distribution and dispersal of plants is too large to be discussed here. I refer the reader to the book entitled *The Dispersal of Plants throughout the World* by H. N. Ridley, 1930,[10] for sufficient information on this subject. The authors of the local floras such as Prain, Cooke, Gamble, Brandis, Duthie,

Haines and others have mentioned in their works some of the plant intruders of this country. Kashyap has recorded some of the foreign plants in his article on "Notes on some foreign plants which have recently established themselves about Lahore."[7] "In the list of species and genera of Indian Phanerogams not included in Sir J. D. Hooker's *Flora of British India*,"[5] Calder, Narayanaswami and Ramaswami have compiled in alphabetical order, the names of species published up to 1924 which were not noted in *Flora of British India*. This work covers 157 pages. Recent writers such as Brühl, Blatter, Parker, Kanjilal (Senior and Junior) Sabnis, Fyson, Parkinson, Mayuranathan, Tadulingam and the writer and others have also reported in their works some of the foreign plants. There has become, as the author experiences during his association with the herbarium of the Royal Botanic Garden, Calcutta, a large accumulation of foreign specimens. A comprehensive list of these 'Plant Immigrants' will be published in course of time.

Some of the most common foreign weeds chiefly hailing from tropical America have of late been almost terrestrial pest in different parts of the country. These weeds cover sometimes acres after acres of field or open places, and miles and miles along the railway lines forming more or less a pure association of their own. *Eupatorium odoratum* encroaches upon outskirts of the tropical evergreen forests in South Burma and penetrates into the Terai of the Eastern Himalayas sometimes struggling to replace the characteristic Savanah formation of this region. Some again spread rapidly in the plains and ascend with equal vigour to the hills sometimes reaching even an elevation of 10,000 ft. These plants are mostly perennial and may be called in general weeds including herbs, undershrubs and climbers. Some of them flower throughout the year and some in spring from January to February. Fruits ripen before the rains from March to April. Some of the species more or less dry up in the hot weather. The climax of growth of most of these species reaches within two to three months after the rains—say from September to December. The rapid spread of *Eichhornia speciosa*, *Croton sparsiflorus*, *Eupatorium odoratum* and *Lantana camara* within a fairly short period has become such a menace to cultivation that questions were raised in the local Legislative Councils to find out means for their control and eradication. The question of eradication of *Eichhornia speciosa* (water hyacinth) is still uppermost in our mind. The writer, as hinted in his paper entitled "Role of Aquatic Vegetation in the biology of Indian waters"[2] is of opinion that the eradication of water hyacinth, as also the other terrestrial species, can alone be done by mechanical means and organised labour. I have studied the question of eradication of water hyacinth since it was tackled by Dr. P. Brühl from 1920 onwards. I have had the opportunity of visiting different affected areas in India and Burma. I am convinced that there is no royal road to eradicate this pest save and except by mechanical means. Utilisation of water hyacinth compost as manure is, I believe, not so very tempting to the agriculturists as to induce them to apply their whole-hearted effort for eradication. Manufacture of alcohol from water hyacinth on a commercial scale is rather doubtful, but if it proves successful by the attempt of Dr. H. K. Sen, it might be a tempting offer. In any case in this country under the present circumstances, it appears to me that a certain amount of forced labour or legislation might have, in the beginning, desirable effect to stir up the landholders to take up the work in right earnest. The prospect of utilising water hyacinth as manure, potassium salt, alcohol and other bye-products might also encourage educated people and zemindars of the affected areas to influence the tenants for exerting their manual labour to the full extent for the eradication of this pest which day by day is leading them to heavy financial losses.

The control of terrestrial pest is not so very complicated, as it requires keen watch in uprooting the plant before the fruiting period. In this way after three or four years weeding they will be quite under control. In the forest areas careful burning of the weeds in proper time will have considerable effect in checking their growth. Thus by careful weeding the author finds large plantations, gardens and estates are kept free from growth of undesirable weeds. In this country edaphic and climatic conditions, vast areas, finance and other labour factors are not favourable to the use of spray and chemicals.

The American plants seem to have particular liking for the Indian soil, so that once they can set foot on any part of India they spread like wild fire in no time. Of such

may be mentioned—the Euphorbiaceous South American *Croton sparsiflorus* which Prain records as occurring in the Royal Botanic Garden in 1904. This alien species was evidently, as Mohr refers in his *Plant Life of Alabama* in 1901, was introduced in ballast and found its way to India *via* Malay Peninsula, South Burma and Aracan sea coast. Both Brühl and Joshi remark that this plant favours riverside and water courses. The writer thinks that this plant first settles down along the river-side, water courses of various sorts and even along the edges of ditches. This is evidently due to its innumerable seeds having been washed down by rainwater are finally distributed by the current of rivers. The seeds thus carried by water are stranded along the margins of watercourses or open chars of rivers and canals and grow there under suitable conditions. In this way the plants are securely placed in their new habitat, and after first fruiting period the cocci are scattered and the area of the spread of this plant increases in mathematical proportion. Its access to Benares is very likely by boats plying in the river Ganges or by human agency or by trains running from Bengal to the Upper Gangetic plain. The writer during his recent tour followed this species down to South Burma where it might have reached by the sea along the Aracan sea coast. Its luxuriant growth in masses forming pure association in open fields in some parts of Bengal sometimes lends a touch to the landscape. It spreads right up to the foot of the Himalayas in Northern Bengal. In South India it has been observed by Mr. V. Narayanaswami that this plant spreads particularly along the Railway lines and embankments and extends up to the foot of the Nilgiri Hills. It is not very common in Bihar and Orissa. It has become a veritable pest in Bengal and it is high time that steps should be taken for its eradication, as its growth increases not only the labour charges but also reduces the fertility of the soil. The species appears to favour moist tropical areas and slightly alkaline soil conditions. The plant is not liked by cattle. *Scoparia dulcis*, another tropical American erect small medicinal herb, unknown in Roxburgh's time, is nowadays common everywhere and extends even up to the Terai region chiefly following the open roads and pathways. This plant belongs to the family of Scrophularineæ. *Eupatorium odoratum*, a Compositaceous plant, known by the local people as "Assam lata," is a tall scandent undershrub introduced after Roxburgh's time from Jamaica, West Indies. Hooker reports its occurrence in Assam, S. Burma and Malay Peninsula. This species is at present wild everywhere in the eastern and southern parts of the Indian Empire. This is the most common plant along the railway lines, in village shrubberies and fallow lands in Assam, Bengal, Southern India and Burma. In Assam, especially along the borders of Sylhet hills and the bases of the Naga Hill ranges, it becomes such a dominant species that it may be called *Eupatorium odoratum* association. Such association is not infrequently met with in the secondary formation of the tropical rain forests of S. Burma. Predominance of its growth is also noticed along the base of the Sikkim, Bhutan, the Garo Hills, Khasia and Jaintia hill ranges and Manipur in the east and Madhupur jungle, Mymensingh, Bengal in the west. It is very likely that the plant might have been introduced from the West Indies to India and Burma by seeds confined to the ballast heaps of Cargo boats calling at Singapore. From the Malayan port the plant found its way into Lower Burma. The line of distribution gradually extends further inland and then bifurcating—one branch extending up the duars of N. Bengal and Assam ranges where it finds ideal condition of growth; and the other to the west Bengal, *via* Chittagong Hill Tracts, Hill Tipperah, Dacca and Mymensingh. It is now making attempts to encroach upon the boundaries of Bihar and further north-west towards upper Gangetic Plain. It rapidly replaces the indigenous shrubby and herbaceous association.

The herb *Ageratum conyzoides* Linn., sometimes known as 'Goat weed' belonging to the family of Compositæ, is a native of tropical America. It follows more or less the same path as that of *E. odoratum*. The plant is a small gregarious herb spreading nearly all over the country except very dry parts—ascends from the sea-level to 8,000 ft. or more in altitude in the eastern Himalayas. The species is abundant in Ceylon too. This species is considered to have been introduced by man to the different parts of the world. *Mikania scandens*, another tropical American plant of the family of Compositæ, unknown in Voigt's time, has of late been a widespread climber. The eradication of this climber is difficult due to its vegetative propagation by roots developing from the

nodes and to its profuse growth of flower heads. Its occurrence on shrubs, trees, bushes and marshy areas even over-choked up tanks, is a familiar sight in the Lower Gangetic and Assam and Burma plains. Hooker reports its occurrence in Assam, Burma and Malay Peninsula. The spread of this climber may carefully be watched by the neighbouring provinces and steps should be taken to prevent its entrance. The Central American *Lantana camara* of the family of Verbinaceæ commonly met with in this province in village shrubberies is a veritable terrestrial pest in the Deccan peninsula and the Carnatic. It is reported to occur in the Lower hill forests of the E. and the N.-W. Himalayas, Bengal, Assam, Burma and the Andamans as well. The plant is seriously interfering with cultivation and forest operation and its eradication has attracted attention of local people. Of recent years the South American species, *Heliotropium curasavicum*, recorded from the Madras Presidency, though grown in Serampore was not mentioned by Prain in his *Bengal Plants*[8] and in his paper on the "Vegetation of the Districts of Hooghly, Howrah and 24 Parganas."[9] Brühl mentions it as 'domesticated in Serampore'. The writer finds it spreading over moist areas of Salt–lakes near Calcutta. It is gradually approaching the town covering sometimes in dense masses large plots of lands. But *Suaeda maritima*, as noted in my paper on the "Flora of salt lakes, Calcutta"[1] gains the upper hand in the struggle for existence between the two species in the salt-lakes proper. The Tropical American Solanaceous plant *Solanum glaucum* is an interesting slender rather tall undershrub with beautiful glaucous linear acute leaves and pale bluish flowers. It has been found growing recently in the neighbourhood of Sundribuns. It has been noticed lately proceeding further inland in the 24 Parganas not very far from Calcutta. It was cultivated in the Royal Botanic Garden in 1899. *Argemone Mexicana*, a native of Mexico, as noted by Joshi, is a common roadside and field weed growing everywhere. This Mexican poppy of the family of Papaveraceæ has already been mentioned in 1875 by Hooker and Thomson in the *Flora of British India*—as "naturalised throughout India". The seeds of this species are disseminated by rain-wash. *Opuntia dillenii*, another American cactus, is confined to the sandy areas especially along the seacoasts of Orissa and drier parts of India, where the spread of this species is so much felt that attempts have been made by the Agricultural Department to kill the plants by means of (cochineal) insects. Dr. H. Pruthi of the Zoological Survey of India has been kind enough to inform me that two cochineal insects, *Dactylopius tomentosus* and *D. indicus* are useful for the eradication of prickly pear (*Opuntia* Sp.). The Loktak lake of Manipur and other marshy areas in Assam are infested with *Polygonum orientale* which is now being replaced by *Eichhornia speciosa*. The representatives of Gramineæ are well known for their long range of distribution and adaptability. I mention here *Anastrophus compressus* only, recorded from this country for the first time by Brühl occurring in the Royal Botanic Garden.[4] Although this plant has been spreading rapidly on the grounds of the Botanic Garden, especially in shady areas, and observed to occur in and about Ballygunge maidan, its spread is not noticed during these years to be so fast as that of its other kindreds.

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