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Ancient crop economy of Harappans from Rohira, Punjab (C. 2,000—1,700 B. C.)

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ABSTRACT

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This paper records the discovery of seven kinds of carbonised grains belonging to the Indian dwarf-wheat, emmer wheat, hulled barley, naked barley, lentil, horse-gram and fenugreek from the habitational deposits of mature-Harappan culture dating back from C. 2,000 to 1,700 B.C. at an ancient mound in Rohira Village, district Sangrur, Punjab. The remains of emmer wheat (*Triticum dicoccum*) and fenugreek (*Trigonella foenum-graecum*), both of Mediterranean region and Central Asia, have been reported for the first time in the Harappan economy. The present finds further throw light on the crops cultivated by Harappans about 4,000 years ago in the plains of Punjab in India.

Key-words—Palaeoethnobotany, Carbonised-grains, *Triticum*, *Trigonella*, Harappan Culture (India).

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सारांश

पंजाब में रोहिड़ा से हड़प्पा कालीन प्राचीन फसल अर्थ-व्यवस्था (लगभग 2,000 से 1,700 वर्ष ई० पूर्व)

कृपा शंकर सारस्वत

पंजाब में संगरूर जनपद के रोहिड़ा नामक गाँव में विद्यमान एक प्राचीन टीले से लगभग 2,000 से 1,700 वर्ष ईसा पूर्व की हड़प्पा-सभ्यता के आवासीय निक्षेपों से भारतीय बौना-गेहूँ, एँमर गेहूँ, शल्क युक्त जौ, शल्कविहीन जौ, मसूर, कुल्थी एवं मेथी के कार्बनमय दानों का अभिलेख किया गया है। हड़प्पा कालीन अर्थ व्यवस्था में एँमर गेहूँ (ट्रिटिकम् डाइकोक्कम्) एवं मेथी (ट्राइगोनेल्ला फ़ीनम-ग्रीकम्), जो कि मूलतः केन्द्रीय एशिया व भूमध्यसागरीय क्षेत्र के हैं, का यह सर्वप्रथम अभिलेख है। इन अन्वेषणों से भारत में पंजाब के मैदानों में लगभग 4,000 वर्ष पूर्व हड़प्पा कालीन मानव द्वारा उगाई गई फसलों पर प्रकाश पड़ता है।

INTRODUCTION

THE ancient mound in the village Rohira (lat. 30°35′N & long. 75°50′E), district Sangrur of Punjab, is situated about 13 km from Malerkotla township on the Malerkotla-Ludhiana Road, about 2 km south of the road. The mound, as now exists above the surrounding agricultural land, measures about 6 m in height and covers an area of about 15 acres. The rest of the portion has been levelled off for cultivation. The Department of cultural Affairs, Archaeology and Museums, Punjab has recently carried out archaeological excavations in an area of about 900 sq m on the main mound.

The excavations have revealed the sequence of cultures from C. 2300 B.C. up to Early Historic and Medieval times. The earliest is the pre-Harappan phase (C. 2,300-2,000 B.C.) succeeded by the mature-Harappan (C. 2,000-1,700 B.C.) and thereafter, the late-Harappan phase dating back from C. 1,700 to 1,100 B.C. The carbonised grains were collected from the trench C-8, stratum 4 at one meter depth (Period IB), which collectively reveal a rich and varied crop economy of the Harappans at this site.

MATERIAL AND METHODS

Two lots of the carbonised grains mixed with mud were handed over to the author by the excavator, Shri G. B. Sharma. Some of the grains are complete while the rest are broken ones. To remove the dust particles the grains were repeatedly washed with water and then treated with 5 per cent acetic acid for about 10 minutes

to remove the remaining dirt. The duly washed grains have been examined under a stereobinocular microscope and the identification is based on the external morphological grounds.

For comparative study authentically identified material of extant plants was made available by the herbarium of the Birbal Sahni Institute of Palaeobotany and the Indian Agricultural Research Institute, New Delhi.

DESCRIPTION

In all, the following seven kinds of grains have been described.

1. Dwarf Wheat : *Triticum sphaerococcum* Percival

Pl. 1, fig. 1

The kernels of shot wheat, inspite of some puffing during carbonization, have retained much of their broad and somewhat rounded or oval-round shape with broad and circular hump on the dorsal side. They measure 4.00-3.00 mm in length, 3.50-2.50 mm in breadth and 3.00-2.25 mm in thickness. The pericarp of some of the grains has got partly rubbed off. On the basis of these characters the carbonised grains differ from those of *T. aestivum* and *T. compactum*, but resemble that of *T. sphaerococcum*. The ratios of various indices based on the dimensions of carbonised grains, as given in Table 1, also compare with those of *T. sphaerococcum*. The L/B and L/T indices under 2 and B/L index above 0.50 as suggested by Vishnu-Mittre and Savithri (1982) for shot wheat, further support the identification of ancient Rohira wheat to *T. sphaerococcum*, though the number of the kernels was limited for such statistical considerations.

Table 1—Dimensions of *T. sphaerococcum* grains (in mm)

	Length (L)	*Breadth (B)*	*Thickness (T)*	*L/B*	*L/T*	*B/L*	*B/T*	*T/L*	*T/B*
	3.00	3.00	2.70						
	3.00	3.40	3.00						
	4.00	3.50	3.00						
	3.70	3.00	3.00						
	3.70	2.80	2.50						
	3.60	3.00	2.50						
	4.00	3.00	2.50						
	3.50	2.30	2.25						
Average:	3.56	3.00	2.68	1.19	1.33	0.84	1.12	0.75	0.89

2. Wheat : *Triticum* sp.

Pl. 1, fig. 5

The lot is represented by a dozen elongated grains tapering towards both the ends with distinctly curved dorsal side and flattish ventral side. The distortion during the course of preservation in some of the kernels seems to have blurred the distinct morphological appearance. On a close examination under a stereobinocular microscope, a few kernels have been found to be partially enclosed within a hull or glume showing very faint longitudinal striations. One of the kernels (Pl. 1, fig. 5) has a small part of rachis attached. The grains measure 5.60-4.00 mm in length, 2.50-2.00 mm in breadth and 2.00-1.75 mm in thickness. The cheeks along the sharp and deep ventral furrow are slightly puffed. Embryo is rather large. The dimensions of well-preserved nine kernels are given in Table 2.

Table 2—Dimensions (in mm) of wheat (*Triticum* sp.) grains

	Length (L)	*Breadth (B)*	*Thickness (T)*
	4.00	2.00	1.80
	4.00	2.50	2.00
	5.50	2.00	2.00
	5.00	2.00	1.75
	5.00	2.50	2.00
	5.50	2.50	2.00
	5.20	2.30	2.00
	5.50	2.30	2.00
	5.60	2.40	2.00
Average:	5.03	2.27	1.95

PLATE 1
(Magnification of grains in mm)

1. Shot wheat (*Triticum sphaerococcum*) grains.
2. Lentil (*Lens culinaris*) seeds.
3. Fenugreek (*Trigonella foenum-graecum*) seeds.
4. Naked barley (*Hordeum vulgare* L.-var. *nudum*) grains.
5. Emmer wheat (*Triticum dicoccum*) grains.
6. Horse-gram (*Dolichos biflorus*) seeds.
7. Grains of hulled barley (*Hordeum vulgare* L. emend. Bowden).

PLATE 1

The kernels enclosed in a hull, elliptical in shape with tapering ends and deep ventral furrow differ from those of cultivated barley having pointed embryonal end and shallow and wide ventral furrow, and also differ from the caryopses of oat (*Avena* sp.) which are more slender and sharply pointed at one end. Taking into consideration the feature of rechis found attached to one of the carbonized kernels, a comparison has been attempted with the kernels of wild grasses of tribe Festuceae (such as *Bromus*, *Festuca*, *Glyceria*, *Poa*, *Eragrostis*, etc.) growing in north-western India, which are characterised with short, erect stalk or rachis at the base of grain-enclosing floret. There is nothing common in these, particularly in the shape of kernels and the features of embryo, which could be regarded as comparable with the unknown grains. Further, the carbonized grains are much unlike those of the free-threshing wheats, viz., the bread wheat (*T. aestivum*) which have grains broader in middle and narrower towards both the ends and with raised dorsal side; club wheat (*T. compactum*) of which grains have rounded or broader apex and the shot wheat (*T. sphaerococcum*) which have short, more or less rounded grains. However, on morphological grounds, the carbonised, elongated and elliptical grains with distinctly curved dorsal side, seem to compare with those of Emmer wheat (*T. dicoccum*). It is important to note that in Emmer, the rachis does not break readily but yields to pressure. The part of rachis attached with one of the carbonized kernels (Pl. 1, fig. 5) further suggests close resemblance with those of Emmer-like form. The ancient grains having thickness less than, or at the most equal to, the width (Table 2) further compare in breadth-thickness ratio with those of cultivated *T. dicoccum* as suggested by Helbaek (1958).

The emmer is the crop of West Asia and Egypt and it might have entered through the west coast of India by the traders (Howard, 1916; Rao, 1974). The modern cultivation of emmer in the parts of peninsular India (especially in Gujarat) and its total absence in the main wheat producing zones of north-western, north-eastern and central India is suggestive of its introduction through western coastal regions. If the identification of these grains to *T. dicoccum* is correct, it may suggest its cultivation in the plains of Punjab about 4,000 years ago. This inference is likely to be questioned on botanical and archaeobotanical grounds. Emmer wheat is not cultivated in north-western India today. If emmer is presumed to have existed in ancient agriculture in the region of Punjab, this type would have been represented elsewhere also in the contemporaneous or earlier or later archaeobotanical finds. Moreover, it has not been represented in the highly advanced agriculture of Harappans who have, evidently, been regarded on archaeological grounds to have established their intimate contacts and trade with western Asia. In addition, the north-western India is not the ancestral home of *T. dicoccum* as its evolution is regarded to involve the occurrence of its wild progenitors, i.e. wild emmer grass (*T. dicoccoides*) and goat-face grass (*Aegilops tauschii*). *Ae. tauschii* is, however, reported to occur in Kashmir (Bor, 1960) but not in the plains of Punjab. Wild emmer grass does not occur in the Indian subcontinent.

The possibility of ancient wheat kernels, belonging to some aberrated forms of cultivated wheat, may also not be completely ruled out. In modern wheat crops, aberrant grains do occur which differ in their appearance from the normal ones and their classification up to specific level can hardly be justified on the morphological grounds. A critical observation on the occurrence of aberrant grains is explained as a result of the presence of a few wheat plants in the barley fields and vice versa. These aberrant kernels reveal the characteristics intermediate between wheat and barley. Such wheat grains have shallow ventral furrow which does not run end to end as in barley. The aberrant barley grains share the characters of wheat grains in having smooth surface and dorsal hump (Vishnu-Mittre & Savithri, 1982). The carbonised grains enclosed in the husk compare with the hulled barley; the deep, narrow, ventral furrow running end to end is manneristic of wheat caryopses. Further, the Rohira grains are characteristically elliptical having dorsal side curved which does not compare with flattish dorsal side of barley. Features of embryo are similar to wheat and the pointed embryonal beak, as in barley, is also wanting in the present carbonised grains. Thus the Rohira grains do not compare morphologically with the aberrant grains of both wheat and barley. The elliptical hulled grains tapering at both the ends, with curved dorsal side, deep and narrow ventral furrow running end to end and large, broad embryo, are comparable in all respects with cultivated emmer wheat (*T. dicoccum*). The part of tough rachis attached to one of the kernels further supports the same contention. These characters have been regarded useful not only for the modern wheats but also for the classification of ancient wheats (Helbaek, 1960). Therefore, the ancient glumed wheat from Rohira is placed under a tetraploid species of *Triticum dicoccum* Schübl.

3. Barley : *Hordeum vulgare* L. emend. Bowden

Pl. 1, fig. 7

Description—All the 15 complete carbonised kernels of barley are partially or completely enclosed in a thick husk. They are angular in cross view because of the closely appressed palea veins running longitudinally. The longitudinal striations of husk are more distinctly observed on the ventral cheeks along the shallow furrow which arises from the base and gradually widens towards the upper end of the grains. The kernels vary from 7.40

to 4.40 mm in length and 4.00 to 2.70 mm in breadth (Table 3). The lot of the carbonised grains reveals a mixture of comparatively larger and straight grains having a distinct bulge in the middle, and smaller, somewhat assymmetrical grains with ventro-lateral twists. In this regard, the carbonised barley grains belong to the six-rowed form of hulled barley in which all the three florets present at each node of spike are fertile. The middle caryopses have developed a distinct bulge and the lateral ones are pushed outwardly developing the characteristic twists.

Table 3—Showing length and breadth (in mm) of carbonised barley grains

	Length (L)	Breadth (B)
	7.40	4.00
	6.00	3.00
	5.20	3.30
	6.90	3.00
	6.00	3.50
	5.00	3.00
	6.50	3.80
	4.40	3.00
	6.20	3.00
	5.90	3.80
	5.30	3.20
	5.50	3.20
	6.00	3.00
	6.00	2.70
	6.00	2.90
Average:	5.89	3.23

4. Naked barley : *Hordeum vulgare* L. var. *nudum*

Pl. 1, fig. 4

Description—Six kernels measuring 6.50-5.00 mm in length and 3.50-3.00 mm in breadth (Table 3) appear to be much broader in relation to their length than the kernels of hulled barley. The grains are almost circular in cross view and some of them exhibit slight lateral twists. In the absence of husk (lemma & palea fused with pericarp), the grains appear hull-less or naked. The peculiar transverse rippling on the grain surface, more prominently on the cheeks along the shallow furrow on ventral side, developed as a result of pericarp contraction during drying of the kernels. They compare in all respects with those of the six-rowed form of naked barley.

5. Lentil : *Lens culinaris* Maedik

Pl. 1, fig. 2

Description—Four seeds of lentil measuring about 3.30-2.50 × 3.00-2.20 mm (L × B) are circular and flattened with keeled-margins. They are more or less

Table 4—Showing length and breadth (in mm) of naked-barley grains

	Length (L)	Breadth (B)
	6.00	3.20
	6.50	3.50
	5.00	3.00
	5.70	3.30
	5.50	3.40
	5.00	3.20
Average:	5.61	3.26

lenticular in appearance. The hilum is small and acutely lanceolate in shape. In one of the seeds, the seed coat has partly been rubbed off. Morphologically, the seeds compare with some small-seeded variety of *Lens culinaris*.

Table 5—Dimensions (in mm) of Horsegram seeds

	Length	*Breadth*	*Thickness*
	4.50	2.70	2.00
	4.70	2.50	2.20
	4.00	2.50	2.20
	4.80	2.80	2.25
	4.40	3.50	2.30
	5.00	3.00	2.30
	5.00	2.40	2.00
Average:	4.63	2.78	2.18

6. Horse-gram : *Dolichos biflorus* Linn.

Pl. 1, fig. 6

Description—There are, in all, seven ellipsoid and somewhat kidney-shaped, laterally flattened complete seeds and the rest are broken. Seed surface is smooth. The small elliptical hilum measures 1.30-1.00 × 0.50 mm. The seeds measure 5.00-4.40 mm in length, 3.50-2.40 mm in breadth and 2.30-2.00 mm in thickness. The cotyledon (the left most in upper row) measures 3.70 mm in length, 2.40 mm in breadth and 1.25 mm in thickness. The seeds resemble those of *Dolichos biflorus*, vernacularly known as Horse-gram or Kulthi.

Table 6—Showing length and breadth (in mm) of fenugreek seeds

	Length	*Breadth*
	3.30	2.70
	4.00	3.00
	3.00	2.70
	3.70	2.50
	3.70	2.30
	3.70	2.50
Average:	3.56	2.61

7. Fenugreek : *Trigonella foenum-graecum* L.

Pl. 1, fig. 3

Six seeds of fenugreek measuring 4.00-3.30 mm in length and 3.00-2.30 mm in breadth have been encountered. They are somewhat oblong, having deep grooves across one corner. The seeds in the upper row (Pl. 1, fig. 3) show the radicle appressed to cotyledons up to approximately more than half the length of seeds. The dimensions of the seeds are given below in Table 6. They are very much alike, both in shape and size, to those of modern fenugreek or Methi seeds used in spices and condiments.

DISCUSSION AND CONCLUSIONS

The grains recovered from Period IB (Harappan occupation) at Rohira and dating back to about C.2,000-1,700 B.C., amply reveal the rich and varied crop economy of the Harappans in the plains of Punjab. The grains comprise two forms of barley—Hulled (*Hordeum vulgare* L. emend. Bowden) and naked (*H. vulgare* L. var. *Nudum*); two forms of wheat—shot wheat (*Triticum sphaerococcum* Percival) and some grains comparing with those of Emmer (*T. dicoccum*); lentil (*Lens culinaris* Maedik); horse-gram (*Dolichos biflorus* L.); and fenugreek (*Trigonella foenum-graecum* L.).

The grains of hulled and naked barley and shot wheat (*T. sphaerococcum*) have already been reported from Harappa, Mohenjodaro and Chanudaro in Pakistan and Pre-Harappan levels at Kalibangan in Rajasthan, India (Percival, 1921; Stapf, 1931; Vats, 1941; Shaw, 1943; Vishnu-Mittre, 1974; Vishnu-Mitre & Savithri, 1982). These crops were widely cultivated throughout the Harappan empire in the north-western part of the Indian subcontinent.

The cultivation of barley by the Harappans is clearly understood and explained because of its adaptability to extremely dry climate and saline or alkaline conditions of soil. Further, barley, being tolerant of alkalinity, frost and drought, needs less nutritive requirements than wheat. Obviously, it was the most profitable crop of Harappans in the north-western regions of India.

Shot wheat (*T. sphaerococcum*), selected by Harappans at Rohira, is a highly drought resistant species. It can adapt under adverse climatic conditions and to the soil having low fertility with high percentage of salts. This species can thrive in the areas with low precipitation. The dry climate is an added advantage to the pest control of this wheat crop which is highly susceptible to the pestiferous infections in humid conditions. The Harappans at Mohenjodaro and Chanudaro were growing and consuming the grains of both *T. sphaerococcum* and *T. aestivum/T. compactum*; at Rohira the grains could be referred only to *T. sphaerococcum*. *T. sphaerococcum*, formerly grown in Sind and Punjab, has now gone out of cultivation in these areas and at present it is grown as an important crop in Baluchistan.

Further discussion on the wheat grains comparable with those of emmer is unwarranted until their identity has been established from some other sites. It may, however, be of interest to mention that the emmer wheat along with einkorn wheat (*T. monococcum*), hard wheat (*T. durum*) and bread wheat, i.e. *T. aestivum* has been reported from the Neolithic level at Mehrgarh in the Kachi plains of Baluchistan (Jarrige & Meadow, 1980). At Mehrgarh and its surrounding area on the Bolan, a continuous sequence of occupations has been noticed from Neolithic to Harappan times. But strangely, emmer wheat has not been encountered in the Harappan deposits at this site.

Lentil is the pulse crop of much ancient cultivation. In northern India, the lentil seeds have been encountered from Neolithic sites at Gufkral in Kashmir Valley dating back about C. 2,500 B.C. (Sharma, 1982) and at Chirand in Bihar (Vishnu-Mittre, 1972) dating back between C. 1,900-1,400 B.C. (1,755 ± 155 to 1,270 ± 105: Agrawal, Kusumgar & Pant, 1975). Besides, its seeds have been recovered from the late Harappan site at Hulas (District Saharanpur) in western Uttar Pradesh (Saraswat, unpublished).

Horse-gram (*Dolichos biflorus*) is an indigenous species which is cultivated as a dry crop in most of the States. It can easily sustain on poor soils and is hardy and drought-resistant. The seeds are extensively used as a feed for cattle and horses in the same way as of gram (*Cicer arietinum*) and consumed by man also.

Wild fenugreek (*Trigonella foenum-graecum*) now grows in Kashmir, Punjab and Upper Gangetic plains. It is widely cultivated in many parts of India. In Punjab, it is cultivated as a fodder crop. The fenugreek is indigenous to the countries bordering the eastern shores of the Mediterranean, extending to Central Asia. Its independent centre of origin is believed to be in Ehiopia (Anonymous, 1976). The occurrence of seeds of *Trigonella foenum-graecum* identified at ancient Rohira is a new contribution to the ancient plant economy of India.

As a result of intensive explorations, the area of Harappan Culture complex has expanded enormously, but the plant remains have not frequently been encountered for botanical study at many of the excavation sites. Thus, our knowledge on the Harappan food economy has not progressed very far. The presence of barley at Kalibangan; wheat and barley at Harappa, Mohenjodaro and Chanudaro; and the predominance of wheat and barley at Rohira too suggests that wheat and barley were the main cereal crops of Harappans in the north-western region of the Indian subcontinent. At Rohira, it is of interest to mention that Emmer wheat and fenugreek seeds have also been encountered with other

food grains. Both these crops do not have their ancestry in India. Moreover, the remains of Emmer wheat and fenugreek have not been found so far at any of the Harappan and pre-Harappan sites. Emmer wheat is originally of West-Asia and Egypt and fenugreek is indigenous to the countries bordering the eastern shores of Mediterranean, extending to Central Asia. Although, their occurrence in the Harappan food economy at Rohira, by and large, is fragmentary, but it is certain that these remains are suggestive of Indo-West Asian connections during the Harappan times. Since the excavations of Harappa and Mohenjodaro, the workers have tried to ascertain every bit of material evidence which may throw light on the Indian contacts with West-Asia. Except for a very few specific items of seals, beads, etc. there is nothing very tangible to establish the fact. Thus, under such circumstances the finds of Emmer wheat and fenugreek bear ample testimony to their importance in context of Harappan contacts with West Asia. The factual informations on plant remains are scanty and widely scattered. Under the present limitations of our knowledge, it is difficult to work out the exact mechanism and source through which these crops of West-Asian ancestry diffused into Punjab. There might have been, probably other plants as well, but certain evidence is lacking. Further investigations on plant remains may, indubitably, provide the valuable informations in this regard.

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REFERENCES

Agrawal, D. P., S. Kusumgar & R. K. Pant, 1975. Radiocarbon and Indian archaeology. *Physics News* **6** : 1-10.

Anonymous, 1976. *Wealth of India : Raw Materials*, Vol. **X**. C.S.I.R., New Delhi.

Bor, N. L. 1960. *The Grasses of Burma, Ceylon, India and Pakistan*-**I**. Oxford.

Helbaek, H. 1958. Plant economy in ancient Lachish, in: *Lachish IV : The Bronze Age*, O. Tufnell (ed). London.

Helbaek, H. 1960. The palaeoethnobotany of the Near-East and Europe, pp. 99-118 in: *Pre-historic Investigations in Iraqi Kurdistan*, R. J. Braidwood and B. Howe (eds). Chicago.

Howard, G. I. C. 1916. The wheats of Baluchistan, Khorasan and the Kurram Valley. *Mem. Dept. of Agric. in India, Bot.* Ser. **8** : Calcutta.

Jarrige, J. & Meadow, R. H. 1980. The antecedents of civilization in the Indus Valley. *Scient. Amer.* **243**(2) : 102-110.

Percival, J. 1921. *The Wheat Plants : A Monograph*. London.

Rao, M.V. 1974. Wheat, pp. 33-45 in: Evolutionary Studies in World Crops : *Diversity and Change in the Indian sub-continent*. Sir Joseph Hutchinson (ed.). Cambridge.

Sharma, A. K. 1982. Excavations at Gufkral-1981. *Puratattva*, No. 11 : pp. 19-25.

Shaw, F. J. P. 1943. Vegetable remains, pp. 250-251, in: *Chanudaro Excavations*—1935-36, E. J. H. Mackay (ed). New Haven.

Stapf, O. 1931. Comments on cereals and fruits, in: *Mohenjodara and the Indus Civilization*, John Marshall (ed.). London.

Vats, M. S. 1941. *Excavations at Harappa*. 2 Vols. Delhi.

Vishnu-Mittre 1972. Neolithic plant economy at Chirand, Bihar. *Palaeobotanist* **21**(1) : 18-22.

Vishnu-Mittre 1974. Palaeobotanical evidence in India, pp. 3-30 in: *Evolutionary Studies in World Crops : Diversity and change in Indian sub-continent*, Sir Joseph Hutchinson (ed.). Cambridge.

Vishnu-Mittre & Savithri, R. 1982. Food economy of the Harappans, pp. 205-221 in: *Harappan Civilization*, Gregory L. Possehl (ed.). New Delhi, Bombay & Calcutta.