

removed from the stack and steeped in water for 5 days. On the 6th day they are washed well, dried in the sun for two or three hours, then with hand they remove the fibre from the stem. The fibre is again dried, made into twists and is kept ready for sale. From steeping till the extraction of fibre, the cooly is paid at 8 annas per *thulam* (14 lbs.) of fibre so extracted and for an acre the yield of fibre is about 50 *thulams* and each *thulam* costs Rs. 2.

**Cost of cultivation of Sunnhemp per acre and the money value of fibre per acre.**

<i>Preparatory cultivation.</i>				Rs.	A.	P.
Ploughing	...	...	...	4	0	0
Cost of seed per acre	...	...	...	12	8	0
Sowing expenses	...	...	...	1	8	0
Cost of irrigation	...	...	...	3	6	0
After cultivation	...	...	...	3	0	0
Harvesting	...	...	...	4	8	0
Bundling and stacking	...	...	...	1	8	0
Steeping and extracting fibre at 8 annas per <i>thulam</i> for 50 <i>thulams</i>	...	...	...	25	0	0
				55	6	0
Yield of fibre per acre—50 <i>thulams</i> at Rs. 2 per <i>thulam</i> .				100	0	0
Profit per acre.				44	10	0

**THE PRESENT POSITION OF THE LAC INDUSTRY IN INDIA**

BY G. NARASIMHA ACHARYA, B.A., M.A.  
Agricultural College, Coimbatore.

The lac industry in India has been drawing much attention in recent years, firstly on account of the "boom" which the industry enjoyed in the post-war period, when fabulously high prices prevailed and a great demand for lac existed which exporters were unable to meet, and secondly, on account of the crisis through which the industry has been passing during the last few years, owing to trade depression and low prices. Probably, no other industry in India is in such a disorganised state, in respect of cultivation and production as well as of marketing and industrial utilisation; and this, in spite of the fact that India holds the world monopoly in this important raw material. The object of the present article is to point out the importance of encouraging the utilisation of lac within the country itself, in the manufacture of various lac products, for which more technical skill than large capital is necessary, so that a demand for lac within the country may be created and, coupled with an organisation among exporting agencies for the proper regulation and control of the lac

export market, the Indian lac industry may be placed on a stable basis, without having to depend for its outlet wholly on the export-trade, which has resulted in the past in speculation, unhealthy manipulation and violent fluctuations.

**Cultivation of Lac.** For the information of those not familiar with the methods of lac production, it may be stated that lac is a resinous secretion formed by a species of scale insect known as *Tachardia lacca* (of which there seem to be many strains in India, e. g. *indica*, *nagoliensis*, *sindica*, *chinensis*, *mysorensis*, *communis*, cf. Beeson, 1924), which live parasitically on the young branches and twigs of host plants like *Palas* (*Butca frondosa*, Roxb.), *Kusum* (*Schleichera trijuga*, Willd.), *Pipal* (*Ficus religiosa*, L.) *Babul* (*Acacia arabica*, Willd.), *Arhar* (*Cajanus indicus*, Spreng.), *Shorea talura*, *Acacia fraserianus* etc., inserting their probosces into the bark of the host plant and absorbing their nutriment from the host, during the completion of their life-cycle, which may take from 17 to 25 weeks (there being thus two or in some cases three lac seasons in the year). The insects continually exude the resinous secretion over their entire bodies, and cover themselves with a cocoon-like shell of lac, which later cohere to form a hard mass over the twigs and branches. The amount of lac secreted by a female is about 100 times that of a male, and the exudation is most active for a period of 8-10 weeks after impregnation by the male, which takes place about 10 weeks after the larval stage. At the end of its cycle, the female dies and from its ovary emerge a swarm of larvae, often amounting to about 1000 per mother insect. For more details regarding the physiology and habits of the lac insect and methods of cultivation, the reader may refer to the memoirs of Stebbing (1908), Imms and Chatterjee (1915), Misra (1923) and Glover (1931).

Even though the lac insect is widely distributed in India, it flourishes best only in certain areas, and it is in these areas that lac is produced in abundance. The lac-belt of India is concentrated in an area comprising Chota Nagpur, Orissa, Berar, the north-eastern half of the Central Provinces, the northern districts of Bengal and parts of the United Provinces, though it tails away in the west to Sind, in the north to the Punjab and in the east to Assam and Burma, the quality of lac produced in the last two areas being comparatively poorer. Small quantities of lac are produced in Mysore and the Hosur Plateau, (Salem District). Outside India, lac is produced in Indo-china, Siam and the Straits Settlements, but the quantities marketed are very small, amounting to about 5% of India's produce. The ecological relationships of the lac insect have not been so far systematically studied. Even in the areas where the lac insect flourishes, the amount of lac secreted by the insects at any given place and in any given season, is a very variable quantity, which is conditioned by a number of factors including (1) the suitability of the host plant, (2) the vitality of the

host plant as determined by conditions of soil, weather, manuring, stage of growth etc., (3) vitality and hardiness of the strain of lac insect; (4) weather conditions, excessive heat or humidity being unfavourable for lac production; (5) absence of the natural enemies of the lac-insect or lac hosts, like fungi, bacteria, parasitic insects, parasitic animals etc., (6) physiological factors like sex-ratio among the insects.

The secretion of the lac insect consists of a mixture of lac-resin, lac-wax, lac-dye and honey-dew. Puran Singh (1911) quotes analyses of crude lac as containing about 65 to 80% of lac resin, about 6 to 10% of the red colouring matter (lac-dye), 4 to 6% of lac-wax, 2 to 5% of vegetable gluten, mixed with accidental impurities such as water (up to 4%) and small quantities of wooden fibre, puparial remains, sand etc.

One interesting feature of the lac industry in India is its highly scattered nature. Even though in favourable years, as much as 743,000 cwts. (or about a million maunds) of lac were exported per annum, several hundreds and thousands of persons (mostly poor peasants and hill-tribes) were responsible for the collection, the individual quota of each producer hardly averaging more than a few seers. Naturally, middle-men play an important role, for good and bad, in the collection and marketing of the produce—a fact which has to be borne in mind in considering the economics of the trade and in devising ways and means for improving the present position.

The lac export trade of India is an old one, but in the early days (1800–1820), large quantities of lac-dye were exported and the preparation of lac-resin (shellac) was considered to be of subsidiary importance. After the advent of coal-tar dyes, however, the demand for lac-dye grew less, so that this commodity went practically off the market after 1890; but, fortunately for India, the demand for shellac showed, after the above date, a rapid and remarkable increase, which reached its height during the post-war period. Now, most of the lac exported from India is in the forms of shellac, only small quantities of inferior forms like grain-lac, garnet-lac, button-lac and stick-lac being sent out; other products like lac-wax and lac-dye do not figure in the export trade.

**Manufacture of Shellac.** The following gives an outline of the indigenous method of preparation of lac for the export market. The twigs containing the lac secretion (stick-lac) are crushed either by hand or by machinery, sieved and winnowed, to separate the granules from the twigs; the residual dust contains some lac with most of the wax and insect bodies. The granules of lac are washed either by machinery or more usually by treading them under feet with water in tanks, in order to remove the lac-dye, which dissolves out into the water; the highly coloured liquid is decanted off and the dye precipitated by the addition of lime or alum and sold in the form of cakes as

crude 'lac-dye'. The washed granules of lac known as "grain-lac" or "seed-lac", are next worked into shellac by transferring them into long hollow cylinders of strong calico, where they are mixed with a little orpiment (arsenious sulphide) and some low-melting resin like Colophony, and carefully heated over a fire, keeping the bag rotated. The lac oozes out through the calico and is scraped with a spatula, mixed with some water and basted into a homogeneous molten mass. The molten lac is spread on the surface of large stone-ware vessels containing hot water, till it is about a foot square and 1/8 inch thick; at this stage, a skilled workman takes it up, waves it in front of the fire to partially soften it, and at the proper moment, seizes it with his fingers, toes and teeth and stretches it into a thin sheet some 3 ft. square, of almost equal thickness through-out. These sheets broken up, constitute the shellac of commerce.

The colour of shellac varies from dark orange to pale yellow, the latter being preferred. Pure shellac is insoluble in water, but wholly soluble in methylated spirits or ethyl alcohol, besides other organic solvents. The trade requirements of good shellac are chiefly cleanliness, as judged by freedom from dirt and insoluble matter or adulterants like rosin, and secondly pale-ness of colour. Shellac is usually sold under the mark "T. N.", though the origin of this mark is not definitely known. "T. N." mark may contain up to 3% of insoluble impurities.

**Lac trade of India.** Most of the lac exported from India is in the form of "shellac", a comparatively smaller quantity of "seed-lac" and negligible proportions of "button-lac" and "stick-lac", being sent out. The relative quantities of these forms which are exported and the important countries which show a preference to particular forms, is shown in Table I.

Table I. Showing exports of different forms of lac.  
(Exports given in thousands of cwts.)

Years.	1925-26	1926-27	1927-28	1928-29	1929-30	1930-31	8 months April -Nov. 1932	Av. price in 1932 per cwt.
Total lac Export ...	539.9	592.0	543.6	743.4	668.9	547.2	284.0	Rs. ..
Shell lac ...	416.6	424.9	404.4	530.7	498.3	366.4	167.4	33
" to U. S. A. ...	226.9	239.5	170.1	237.0	225.7	117.0	46.6	
" to U. K. ...	82.7	86.9	117.6	135.3	120.3	95.8	51.1	
Seed lac ...	37.4	89.4	54.7	92.4	68.0	106.3	90.9	26.
" to U. S. A. ...	32.8	84.0	49.2	82.8	57.0	82.0	66.5	
Button lac ...	21.7	20.6	18.0	24.7	24.2	23.7	11.6	40.
" to U. K. ...	11.0	11.6	11.6	14.7	14.8	15.8	8.2	
Stick lac ...	22.8	7.2	9.1	26.5	6.4	4.7	3.7	19.

(U. K. = United Kingdom; U. S. A. = United States of America).

The figures show that previous to 1928, about 75% of the exports was in the form of shell-lac, about 10% in the form of seed-lac and about 10% in the form of button-lac, most of the seed-lac being taken by the U. S. A. and the button-lac by the United Kingdom; but in recent years, however, U. S. A. have shown an increased demand for stick-lac (probably due to its cheapness and its comparatively "raw condition" amenable for any desired treatments), at the cost of their imports of shell-lac, so that now, computed on total exports, shell-lac has fallen to about 60%, seed-lac has risen to 30% and button-lac has fallen to 5%.

Table II gives an idea of the volume of the total lac export trade of India, since 1880 onward, both in regard to quantity and value. The figures include exports of all forms of lac, like shell-lac, seed-lac, button-lac and stick-lac and the remarks noted under Table I regarding the recent preference of U. S. A. to seed-lac, and the relative volume of trade in the different forms of lac, may be borne in mind while examining the figures given in the table.

Table II. Total Lac Export Trade of India.

Official year April to March.	Lac Exports in thousands of cwts.			Total value of Exports in lakhs of Rupees.	Average price per cwt. in Rs.
	Total Exports.	To United Kingdom.	To U. S. A.		
1880—81	82.1			56.5	69
1890—91.	147.2			87.1	59
1900—01	219.9	73.2	70.9	103.9	47
1902—03	231.6	108.4	82.1	180.8	78
1905—06	263.4	78.5	119.1	310.2	118
1908—09	372.2	93.2	146.8	273.6	74
1910—11	421.6	105.5	161.1	214.3	51
1912—13	428.2	82.2	171.7	211.3	50
1914—15	366.7	89.4	179.7	160.6	43
1916—17	381.4	48.9	240.3	280.3	74
1917—18	322.4	59.5	204.9	377.8	118
1918—19	239.1	67.4	100.2	294.8	124
1919—20	375.7	104.3	228.8	726.4	194
1920—21	308.9	55.1	208.2	758.3	246
1921—22	434.9	86.1	245.2	791.6	182
1922—23	476.0	88.4	246.2	1026.5	216
1923—24	485.7	88.3	245.5	906.3	187
1924—25	428.2	78.9	175.1	755.1	176
1925—26	539.9	96.7	264.9	693.1	128
1926—27	592.0	101.5	327.2	547.2	93
1927—28	543.6	133.3	221.2	693.9	128
1928—29	743.4	156.9	323.3	864.3	116
1929—30	668.9	142.9	286.2	696.7	104
1930—31	547.2	121.4	200.9	313.7	57
1931—32	455.6	105.3	177.5	179.0	39
8 months April— Nov. 1932.)	284.0	67.2	113.5	84.2	29

(The figures for 1900 onward are taken from the "Accounts of the Seaborne trade of India", published by the Govt. of India; those for 1880 and 1890 are taken from Stebbing (1908). On account of the wild fluctuations in price, often from month to month, average prices

have been worked out in the last column by dividing total value of exports by total weight of exports per year, as giving a better indication of the variation of prices from year to year).

The following points may be noted from the figures given in the Table:— (1) The lac trade of India showed a healthy and progressive development up to 1914, when prices were maintained constant in spite of production being quadrupled. (2) During the War period, there was a temporary fall in production due to absence of exports to Germany and other belligerent countries, and the control of the trade by the Munitions Board. (3) In the post-war period of 1919—1924, there was a great increase in demand and rush for lac, on account of increased industrial applications, but production though steadily increasing could not meet the demand, with the result that there was a good deal of speculation, attempts at 'cornering' and artificial manipulation of the market, and a soaring of prices to fabulous levels, e. g., Rs. 246 per cwt. in 1920—21, as compared with the present price of Rs. 29 per cwt. in 1932. It was during this period that attempts were made by the Government of India, as will be described later, to improve the cultivation and production of lac, but such increase could only be slow, considering the peculiar circumstances conditioning the production of lac. It was also during this period of high prices that various shellac substitutes were placed on the market by German and American chemists most of them being condensation products of aldehydes with phenols or amines. (4) To a certain extent, these synthetic products established a foot-hold in the market, and their effect is seen in the succeeding period from 1924 to 1929, when lac production increased, but there was no corresponding increase in demand, with the result that prices began gradually to climb down from Rs. 187 per cwt. in 1924 to Rs. 104 in 1929. (5) After 1929, there has been a rapid fall both in demand and prices, the fall synchronising with the general trade depression affecting all commodities. The export has decreased from 743,400 cwts. in 1928—29 to about 455,000 cwts. during 1931—32, and the figures for the current year promise to be still worse; and the price has fallen from Rs. 104 per cwt. in 1929 to below Rs. 30 per cwt. in 1932, a ridiculously low level which it never reached before, even in the earliest days. (6) Another fact that may be noticed is that our best customers are the United Kingdom and the United States of America. In former years, the U. S. A. took twice or more as much lac as the United Kingdom, but during the last few years, her demands have fallen off (probably due to her greater use of synthetic lac substitutes), while the United Kingdom has maintained hers. Germany, France and Belgium are now taking increasing quantities of Indian Lac.

**Causes for the present depression.** Considering the great importance of lac for the manufacture of several products, whose use is increasing day by day, and the almost monopolist position which India

holds in the marketing of this product, it may seem surprising that the lac trade should have suffered so badly during the present depression, while other less monopolist trades like the Coffee industry of Brazil, the sugar industry of Java and the oil industry of America, have borne the brunt much better. The causes for this anomalous difference are several and among them may be mentioned:— (1) The lack of organization among producers. Only about 5 per cent. or less of the total production is obtained from Government Reserve Forests, while the remaining portion is contributed by a large number of isolated farmers, peasants and hill tribes. The scattered nature of lac cultivation and the part played by middle-men in the trade, has been already referred to. For a cheaper and better method of collection, it has been suggested that co-operative societies may be organised for the purpose, and also that Government might directly purchase the lac from the cultivators at central depots. Ghosh (1929) describes a co-operative organisation backed up by the state, which has been working successfully in the Orissa Feudatory States. Similar attempts to eliminate the middle-men, as far as possible, and establish direct contact between the producer and manufacturer, will serve not merely to cheapen costs but also to improve the quality of lac produced. (2) Another factor which has brought about the deterioration of the lac market, is the wild fluctuations it has been subject to, both in respect of quantities supplied and prices. The crop available in any season cannot be predicted as accurately as in the case of staple products, and as such there is a tendency in western capitals like New York and London to stock immense quantities of lac amounting to 200,000 or 300,000 cwts. at a time, with attendant speculation and manipulation of prices. Lindsay and Harlow (1921) have shown the general inverse relationship that exists between total stocks in London and market prices of lac. This can only be solved by organising an Indian Lac Exchange, say at Calcutta, composed of the lac exporting agencies, who can purchase and stock all available supplies in India and guarantee to the world regular and adequate supplies according to demand. (3) Another adverse factor in Indian lac is the absence of proper grading and standardisation of exported material. Complaints have been received from American and European importers to the effect that even "T. N." quality of lac differs widely in respect of content of rosin and insoluble matter. A more uniform standardisation and a system of grading may help to stabilise prices in accordance with quality. For this, a scientific study of the composition of shellac and improved methods of cultivation, purification and manufacture so as to produce material of uniform quality are necessary. (4) The advent of lac substitutes prepared synthetically in Germany and America, has also played a part in dislodging lac from its natural place in world trade; but these substitutes entered the field in the post-war period when prices mounted high, and it is doubtful whether in these days of low

prices, they can successfully compete with natural lac. Moreover, they cannot be used for all purposes of natural lac, and if cultivation and production be properly organised on an economical basis, there is no doubt that natural lac will again regain its old position. (5). The absence of manufacturing enterprises in India, which could compete with foreign demand in the utilization of lac, has been a serious drawback which has thrown the Indian trade completely at the mercy of the organised markets of the west. Most of the lac now exported is utilized in the manufacture of paints, varnishes, gramophone records and electrical appliances, and as many of these do not need large capital, though requiring specialised scientific knowledge and high technical skill, it should be possible to develop them in India rapidly in the near future. (6). Proper attention has not been paid so far, to the utilization of the bye-products of the shellac industry, like lac-dye, (useful as dye-stuff and nitrogenous fertiliser), lac-wax (as substitute for bees-wax), lac-dust (or "molemma" arising from the 'sieving' preliminary to the washing of lac and containing fine grains of lac mixed with wax, dye and insect bodies), "Kiri" (a refuse remaining in the bag used for making shellac and button lac and containing lac-resin, lac-wax and animal remains), the wash-liquors or leachings in the crushing of lac etc. A scientific study of these products should enable their economic utilization and help to cheapen the cost of production of shellac. (7). The present trade depression and dislocation of exchange are presumably temporary factors, which however have revealed the weak and unsound basis on which the industry has been developed, and the present period should be taken advantage of to re-establish the industry on a sound basis.

**Lac Research in India.** The Government of India, as long ago as 1920, realised the importance of safe-guarding and developing the lac industry, and in 1921, appointed the Indian Lac Cess Research Committee, whose function was to conduct a Lac Research Institute and carry on other work with a view to develop and stabilise the lac industry. The Committee has been financed by the proceeds of a small cess on lac exported from India. They established in 1925 the lac Research Institute at Namkum, near Ranchi, under the directorship of Mrs. Dorothy Norris, and the Institute has carried out much useful work by way of a scientific study of the entomological and physiological problems associated with the cultivation and production of lac.

Research on lac in India has been carried on mainly at three centres—at the Forest Institute, Dehra Dun, at the Indian Institute of Science, Bangalore, and more intensively during the last few years at the Lac Research Institute at Namkum. Most of the work done so far, has been entomological and physiological, and has dealt with subjects like the life-history and physiology of the lac insect (Stebbing,



1908; Imms and Chatterjee, 1915; Glover 1931); the suitability of hosts in relation to yield of lac (Sreenivasaya, 1924; Thakur, 1932); influence of factors like soil, climate, manuring, cultural operations etc. on lac hosts and lac yield (Norris et al, 1929), enemies and pests of the lac insect and lac hosts (Imms and Chatterjee, 1915; Glover, 1931); influence of the sex ratio in lac colonies on lac yield (Mahdihassan, 1926) etc. A certain amount of work has lately been done on the improvement of methods of production of lac and on the properties of shellac, C. G. solution and precipitation methods for the separation of shellac, bleaching of lac, regulation of temperature and moisture in the manufacture of shellac, effect of humidity and storage on button-lac, the iodine value of shellac (Aldis, 1932), the physical properties of shellac solutions, the influence of orpiment on the properties of shellac (Rangaswami, 1932) etc. But very little work has been done in India on the industrial applications of lac, though there is doubtless a wide field in India for the manufacture and sale of such lac products.

The steady lowering of the export demand and the very low prices prevailing, which render lac-production a non-paying concern, have demoralised the lac trade and have told heavily on the progress in lac cultivation. Mrs. Norris (1931), who recently made a tour of the lac area in Burma, has reported that in several areas lac cultivation has been given up on account of the present depression in trade. She remarks: "It was quite obvious that owing to the low price obtainable for lac, no interest whatsoever was being taken in its cultivation." Under these conditions, efforts at introducing improved methods of cultivation or production will prove of no immediate avail, and steps should be taken for finding outlets for the lac already being grown, if not by export to foreign countries atleast by industrial utilization in India.

That this aspect of the matter has not been over-looked by the Ranchi workers, is shown by the following extract from the Annual Report of the Indian Lac Research Institute for 1931-32:— "The state of the lac industry has not been satisfactory during the year; in spite of low prices, a steady decrease in exports has to be noted. General trade depression cannot be accepted as the only cause of this, as figures for synthetic resin production for some time past have shown a steadily increasing trade, in most cases at the expense of the natural resin industry..... In recent years, there has been a growing need for research on the technology of shellac and the problems of its marketing and industrial uses..... It was felt, therefore, that the policy of concentrating on the biochemical problems of lac should be modified. Efforts were accordingly made to round off most of the biochemical investigations and to start new problems of more immediate value to the industry. The possibilities of developing new uses for shellac have been given active consideration."

It is gratifying to note that the Imperial Council of Agricultural Research has taken up this aspect of the matter seriously, and has sanctioned funds for deputing three officers to England for training in research in the industrial applications of lac, with special reference to the manufacture of paints and varishes, plastics and electrical appliances. It is well known that America has till very recently been the main importer of Indian lac, and has been utilising most of it in the manufacture of gramophone records and electrical appliances; and it is satisfactory to note that Government have in view the extension of the scheme to America.

**Industrial applications of Lac.** The wide scope for the industrial utilization of lac in India will be evident from the following list of the varied uses to which lac has been put, both in India and in the west. The lac industry is amongst the most ancient of the minor industries of India. In the Ain-i-Akbari issued by Akbar in 1590, a note is given on the proportions of lac resin employed in the varnishes used for the wood-work of public buildings. According to Sir George Watt, the Palas tree (*Butea frondosa*), which is a common lac-host in Northern India, is referred to in Atharvaveda as "laksha" and in later Sanskrit literature as "Lakshataru" (lac tree). Misra (1923) quotes other references to lac from ancient Indian literature. It has been already mentioned that before the advent of aniline dyes, the lac-dye was popular and was exported in large quantities to western countries. Among industrial applications in India, Stebbing (1907) mentions the following:—"In the village it is used either as a varnish or colour medium in the production of tables, bed posts, chairs, boxes, platters etc. The silver and copper-smiths employ it in their trades, as do the manufacturers of shields, swords etc., which are varnished over with lac. The material is employed in the manufacture of painted pottery in Bengal, Gonda, Lucknow, Oudh, Peshawar and the Punjab. It is used by jewellers and also in the manufacture of the various classes of bangles worn by the lower classes. Lastly, in the large class of toys of every description made in India, lac is extensively used for colouration purposes, whilst marbles, pens, sealing wax, ink bottles, imitation fruit and flowers are entirely made of it." But it has to be admitted that the quantity of lac at present consumed in India is very small as compared with that exported, and the main impetus for the development of the lac industry has been given by the export demand, in relation to which India has been content to be a supplier of raw material.

In the western countries, besides the large-scale application which lac finds in the manufacture of paints, varnishes, plastics, gramophone records and electrical appliances, lac is used for the preparation of polishes, gums, cements, sealing wax, lithographic inks, as stiffening material in the manufacture of silk, felt and straw hats, mixed with

mica as insulating material etc. High grade lacs are used for aeroplanes, as inside lining for shells, pianos, furniture, boot finish manufactures, emery wheels, brushes, for lacquering metals and cables, as blinding agent for moulding compositions etc

Among other uses for shellac, Misra (1923) mentions the following:—“Shellac is used for making milk-churns, shuttles and bobbins; for making grinding stones; for fixing hafts to swords; for the manufacture of micanite, with alternate layers of shellac and mica dust; as a substitute for leather, canvas and shellac being used for the manufacture of shoe-tips; for semaphore signalling and as a filling material for sharpnels; for silvering backs of mirrors; in confectionery as a cover to chocolates; for painting the bottom of ships to prevent the corrosive action of the water on the steel-plates; for encasing cable wires, etc. Bleached shellac is used for making imitation ivory used in the manufacture of billiard balls, backs of brushes, combs, tooth-brushes, poker-chips etc., for all white insulated goods and for the manufacture of paper and leather varnishes.” Besides its value as a dye, lac-dye has been found to possess good manurial value when applied to land.

Lindsay and Harlow (1921) quote the following uses for lac in America:—“Abrasives and emery wheels, varnishes and polishes of all descriptions, billiard balls, moulding and picture frames, saws, glazed paper, photographic supplies, musical and optical instruments, watches, leather, oil-less beeswax, guns, oil-cloth, paper-board, lead pencils, paints and glass, tiles, automobiles, sealing wax, hats, rubber tires, chemicals and drugs, phonograph records, pianola rolls, composition materials, electrical apparatus of all sorts, brushes and brooms, horse shoes, buttons, lacquer, foundry supplies, bottle tops, fly-papers, hardware, toys, sports-goods, typewriters, cements and glues, cutlery, mirrors, jewellery, confectionery, engravers' supplies, mint supplies and fire-works.” It is estimated that 40 to 50% of the entire demand is on account of gramophone records that other individual industries cannot claim more than 5 to 8% each of the total consumption.

What with the low prices prevailing now, the advent of synthetic lac on the market, the disorganised condition of international trade and the gloomy prospects ahead, only a vigorous policy of development of the industrial utilization of lac within India, can hope to save the lac industry from the complete demoralisation and annihilation, such as overtook the indigo and other industries in similar situations in the past.

## Literature Cited.

- Aldis, R. W. (1932). Humidity and storage of Button-lac.—*Indian Lac Research Institute Bull.* No. 5.
- (1932). The Iodine value of Shellac.—*Ibid.* Bull. No. 8.
- Beeson, C. F. C. (1924). What is the Lac insect?—*Indian Forester*, L. 345.
- Fowler, G. J., Sreenivasaya, M. Madhihassan, Setal. (1924—29).—Contributions to the scientific study of the lac industry.—*Jour. Indian Inst. Sci.*, VII, part VII, IX-A, part I; XI-A, part II; XII-A, part VI.
- Ghosh, J. N. (1929). The co-operative purchase and sale of lac in the Orissa Feudatory States.—*Indian Forester*, LV, 495.
- Glover, P. M. (1931). A practical Manual of Lac Cultivation.—Indian Lac Research Institute, 1931.
- Imms, A. D. and Chatterjee, N. C., (1915). On the structure and biology of *Tachardia lacca*, Kerr. with observations on certain insects predaceous or parasitic on it.—*Indian Forest Memoirs (Zoology Series)*, III, 1.
- Lindsay, H. A. F. and Hartow, C. M. (1921). Report on lac and shellac.—*Indian Forest Records*, VIII, part I.
- Misra, C. S. (1923). The cultivation of lac on the plains of India.—*Agr. Res. Institute, Pusa, Bull.* No. 142.
- Nicholson, J. W. (1925). Some notes on lac cultivation.—*Indian Forester*, LI, 483, 553, 605.
- Norris, D., Rangaswami, M., Venugopalan, M. and Ranganathan, S. (1929).—An investigation into the plant requirements of *Zizyphus jujuba* during growth and under lac cultivation.—*Indian Forester*, LV, October 1929.
- (1931). Report on the state of lac cultivation and general condition of the lac industry in Burma, 1931.—Published by the Indian Lac Research Institute, 1932.
- Puran Singh (1911). Note on the chemistry and trade forms of lac.—*Indian Forest Bulletin*, No. 7.
- Rangaswami, M. and Venugopalan, M. (1928—30). Physical properties of Shellac solutions.—*Indian Lac Research Institute Bulletins* Nos. 1, 2 and 4.
- and Aldis, R. W. (1932). Orpiment and the Iodine value of shellac.—*Ibid.* Bull. No. 7.
- (1932). The influence of orpiment in shellac on the protective properties of the varnish.—*Ibid.* Bull. No. 10.
- Stebbing, E. P. (1908). A note on the Lac insect (*Tachardia lacca*): its life history, propagation and collection.—*Indian Forest Records*, I, part I; also *Indian Forest Memoirs (Zoology Series)*, I, part 3.
- Thakur, A. K. (1932). Comparative study of lac hosts with special reference to *Acacia catechu* and *Cassia florida*.—*Indian Lac Research Institute, Bull.* No. 9.
- Watt, G. (1890). *Dictionary of the Economic products of India*.—Vol. II, 409—412; also vol. IV, 570—577.