VEGETABLE GUMS and RESINS

F.N. Howes

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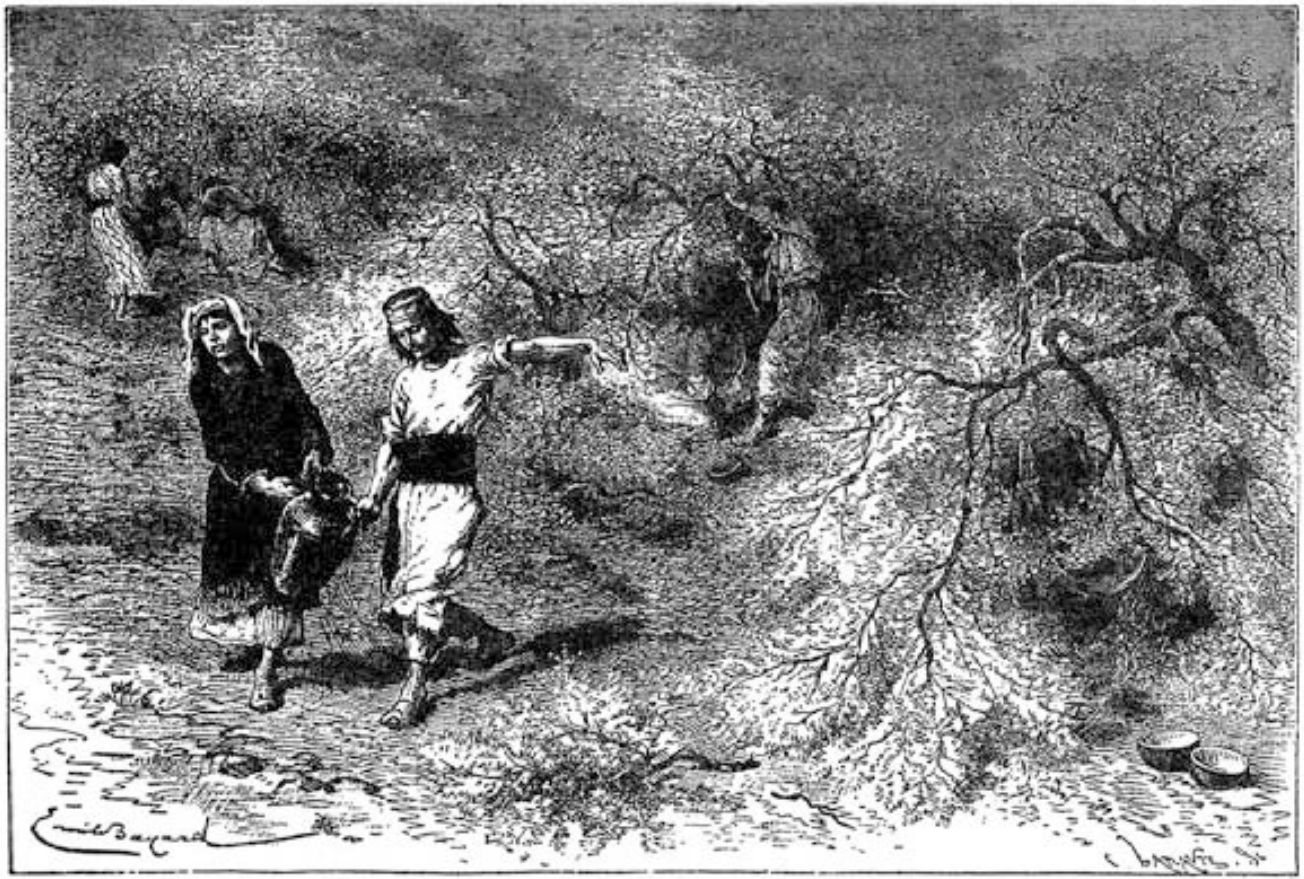

COLLECTING MASTIC — drawing by EMILE BAYARD, after a sketch by Mr. TESTEVUIDE (ca. 1880). — The age long use of this fragrant resin in south eastern Europe and the Near East has been as a masticatory to sweeten the breath and preserve the teeth and gums. It is also used for high grade varnishes for special purposes such as those employed for the protection of pictures.

VEGETABLE GUMS *and* RESINS

by

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Preface

The vegetable gums and resins constitute an important group of economic plant products and are utilised in many ways. Their uses by man, in fact, go back to the earliest times. In modern industry large quantities of both resins and gums have been used for many years in manufacturing processes of various kinds. Their uses continue to increase. The world trade in natural resins has been estimated to be in excess of three quarters of a million tons per annum. The value of the yearly import of gum arabic into Great Britain alone in normal times has commonly been in excess of a quarter of a million pounds sterling. This does not include the various other gums that are in regular use.

The terms "gum" and "resin" are often used in a somewhat indefinite or vague manner. They have been applied to almost any form of plant exudation, even to those that are of a predominantly rubbery nature. The wild or jungle rubber industry that thrived in the past in many parts of the world and was revived during the Second World War, was often referred to as the "gum industry" and those engaged in it as "gum collectors." "Chicle gum" and "balata gum" are expressions frequently heard at the present time. In addition to its use in connection with rubbery exudations of this kind, the word "gum" is also applied to some of the true resins, as in "gum copal," "gum accroides," "kauri gum" and "varnish gums," where the resins employed in varnish making are intended. Fortunately, this misuse of the term "gum" appears to be on the decline.

In this work the words "gum" and "resin" are used only in the more correct or technical sense. No attempt has been made to deal with the large group of substances of a rubbery nature sometimes called "gums." A simple, if incomplete, distinction between gums and resins is that the true gums are more or less soluble in water or swell to a jelly-like mass but remain insoluble in organic solvents, whereas the resins are unaffected by water, but are more or less soluble in various organic solvents. Some plant exudations consist, in the natural state, of a mixture of both gum and resin and are styled gum-resins. The term oleo-resin is used for those resins—of a more or less soft consistency—that occur mixed with a relatively large amount of essential oil. Some resinous plant exudations, particularly those that are medicinal, consist of mixtures of resin, gum and oil, and may be termed oleo-gum-resins.

The number of species that yield gums or resins in greater or less amount throughout the Vegetable Kingdom must be many thousands. For this reason a selective treatment has been necessary in this work. Special emphasis is placed on those gums and resins that are of commercial importance, or which for some reason or other are of special interest. Partic-

ular attention has been given to those that have only become of commercial importance in comparatively recent years, and which are not dealt with in older works of reference. Examples of these are carob seed or locust gum, karaya or Sterculia gum and other tragacanth substitutes, also certain Acacias now known to be exploited for gum, particularly in East Africa.

Owing to the fact that the true gums as a group have entirely different properties and uses from the resins and interest different classes of users, it has been considered desirable to treat the two groups separately. The book has, therefore, been divided into two parts.

Among peoples all over the world, including the aboriginals of Australia and primitive African and Asiatic tribes, certain gums have been used for food as far back as history relates. The adhesive properties of gums have also been utilized from early times, particularly in preparing paints and pigments. Gum arabic in North Africa has been an article of commerce from at least the first century of the Christian era and the trade existed throughout the Middle Ages. The Sudan gum arabic trade with European and other countries developed steadily during the last century, in spite of temporary set-backs through political disturbance, and reached still greater proportions in the present century, thanks largely to improved transport facilities (railways) in the producing areas.

The uses of resins by man are of equal antiquity to those of gums. Many have good combustible properties and have been used for torches and for lighting from time immemorial, particularly by the Malays and other Asiatic and Pacific races. Primitive peoples also commonly make use of resinous materials for caulking their boats. Several of the resins or oleo-resins of the Mediterranean region and near East have long been esteemed for their medicinal properties or their fragrance and hence their age long use for religious purposes (incense). Varnishing or varnish making has always been one of the important uses for vegetable resins and this goes back to early times in some countries. The Ancient Egyptians employed resin (probably a crude oleo-resin) for coating or varnishing mummy cases. There is also evidence that the Incas of South America used embalming resins. It is known that oleo-resins were distilled in Europe in the Middle Ages. The early painters had many formulae and recipes in which the resins and oleo-resins then available, such as mastic, sandarac and pine resin, were ingredients.

With regard to modern uses of vegetable resins the paint, varnish, linoleum, paper sizing and soap making trades use considerable quantities. The relative amounts of the different kinds of resins used for industrial purposes in the past have varied considerably as perusal of the following pages will show. At one time it was thought synthetic resins would completely replace natural resins for many purposes, particularly in the paint and varnish industries, but this has not materialised and the natural resins continue to hold their own and to be imported into manufacturing countries in large quantities. What the future will hold no one can foretell, but in the light of recent developments there are strong indications that the use of natural resins will increase rather than diminish. Recently research has developed new types of resin which are combinations of synthetic and of natural resins, the best examples being the so-called "copal type synthetics."

These resins are proving very promising. They combine desirable features of both the synthetic and the natural or fossil resins.

There have been many important contributions to the literature of vegetable gums and resins, alike from the chemical and physical, and the botanical aspects. A few comprehensive works have appeared in book form and many notable contributions are to be found scattered over a wide range of literature and in periodical publications of all kinds.

With regard to gums, an account of the gums of India was given by Dr. M. C. Cooke, in 1874, from the information then available. This was augmented to some extent a few years later by Dymock Warden and Hooper in their memorable Pharmacographia Indica, and by Watt in his well known Dictionary of the Economic Products of India. At about the same time, J. H. Maiden and his co-workers were making a study of the exudations of Australian plants and published many detailed accounts of the gums and resins of that Continent. In 1909 the Imperial Institute published a special report on "Gums and Resins" which included much useful general information and also accounts of investigations carried out at the Imperial Institute on gums and resins from various parts of the world. Since that time numerous articles on gums have appeared in the Bulletin of the Imperial Institute. In 1911, H. J. de Cordemoy's "Les Plantes à Gommes at à Resines" appeared, and in 1920 a small book by E. J. Parry intended for the general reader was published. Five years later a comprehensive monograph on gum arabic by H. S. Blunt, who had spent many years in the gum producing districts of the Sudan, made its appearance. The East African Acacia gum industry was dealt with in some detail by D. W. Malcolm in 1936.

During the last two decades notable contributions to the chemistry of some of the better known vegetable gums have been made, both in Europe and the United States. Special attention has been given to those gums (mannogalactans) used as stabilizing and thickening agents in various food products. Much of this work has been summarized by A. G. Norman (1937), who points out how much awaits investigation in this particular field. Another admirable account of recent work on gums has been given by C. L. Mantell (1947). What is known of the chemistry of all the more important gums (and vegetable mucilages) used in industry is dealt with by this writer.

Turning to resins, much of the existing knowledge, particularly in relation to their chemistry, is due to the investigations of Prof. A. Tschirch of Berne, the gifted chemist, botanist and pharmacognosist. His work was carried on by collaborators after his death. Tschirch's well known and comprehensive work "Die Harze und die Harzbehälter" first appeared in 1900, with a considerably enlarged edition, in two volumes, in 1906. A third revised edition appeared in 1933-36. Other notable contributions to the literature of natural resins have been "Die Natürlichen Harze" by H. Wolff in 1928 and "Natural Varnish Resins" by T. Hedley Barry in 1932, both these writers being well known authorities on resins. The commercial manufacture of varnishes is a complex and highly technical subject with a literature of its own, recent or well known contributions being those of W. Krumbhaar (1947), H. W. Chatfield (1944), Mantell (1942),

R. S. Morrel (1923), and J. Gauld Bearn (1923). In recent years some of the commercial resins have received more attention than others, both from the laboratory worker and the worker in the field. The literature on colophony or pine resin is now very extensive. Belgian workers have added much to the knowledge of Congo copal. "Manila" or East Indian copal and its exploitation has been closely studied by C. van de Koppel, while T. A. Buckley has given a detailed account of the various Malayan dammars. Lac in India has been the subject of much promising work, thanks to the Indian Lac Research Institute, and to workers in Great Britain and the United States.

A word of explanation may be desirable in connection with the use of botanical names in this book. As the average reader is not likely to be interested in the authority for the name but only in the plant itself or its product, the authorities have been omitted purposely from the text. They are, however, available for those who may require them in the index of botanical names at the end of the book.

The writer is indebted to the Director of the Royal Botanic Gardens, Kew, and to the Director of the Imperial Institute, South Kensington, for the use of specimens and for other facilities afforded by these two Institutions, also to colleagues and to various firms connected with the gum and resin trade for information and assistance willingly given.

The Author.

DEDICATED TO THE COLLECTORS OF GUMS AND RESINS
IN ALL PARTS OF THE WORLD, MANY OF WHOM,
ESPECIALLY ON THE AFRICAN CONTINENT,
LIVE IN HUMBLE CIRGUMST ANCES
AND CARRY OUT THEIR WORK
UNDER ARDUOUS CONDITIONS

FRANK NORMAN HOWES was born Aug. 2, 1901, at Richmond, Natal. Studied in the University of South Africa (M.Sc. 1923) and later as a post graduate student in the University of London. Eighteen months were spent on botanical work (mainly field work) in the Transvaal and Western Cape Province while attached to the Union Botanical Survey. Later held post of Economic Botanist, Agricultural Dept., Gold Coast and then appointed to the Staff of the Royal Botanic Gardens, Kew (Museums of Economic Botany). Visited Malaya, Java, Siam, Burma, India and Ceylon in 1928 in connection with work on banana varieties and disease resistance. Degree of D.Sc. (S.Af.) conferred 1935. Author of "Plants and Bee-keeping", "Nuts", and numerous papers on economic botany. Member of the Imperial Institute Consultative Committee on Gums and Resins.

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Vignettes by WINIFRED WALKER

COLLECTING FRANKINCENSE
Woodcut from PARÉ's *De Distillationibus (1582)*

Part I

GUMS

Chapter I

THE NATURE AND USES OF GUMS

The Occurrence and Origin of Gum in Plants:—The vegetable gums are a group of plant products resembling carbohydrates and widely distributed in the Vegetable Kingdom. They are characterized by the ability to dissolve in water forming viscid solutions, or by absorbing water to form jellies or gelatinous pastes as in tragacanth and allied gums. On desiccation or exposure to the air these solutions or pastes lose their water and dry to hard, clear, rather glassy masses.

Gums are to be found in a greater or less degree in most plant families. Various organs of the plant may produce or secrete them. They may be produced only in very small quantity and not be readily discernible, or they may be produced very copiously forming large, conspicuous incrustations on the surface, as with most of the commercial gums, particularly the tree gums. Certain families of flowering plants are notable for the number of species they contain that are free gum yielders. Notable among them is the *Leguminosae*, in which a hundred or more species of *Acacia* alone are known to yield gum, including those that are commercially important for gum arabic. Several species of *Astragalus* are also free gum yielders and are the source of gum tragacanth. The following are additional notable gum yielding genera in the family—*Albizzia, Bauhinia, Caesalpinia, Ceratonia,* and *Pithecolobium*. Other important gum yielding families are—*Anacardiaceae, Combretaceae, Meliaceae, Rosaceae* and *Rutaceae*.

Various views have been put forward concerning the processes whereby gum is formed in plants. In some instances it is believed that gum is part and parcel of the normal metabolism of the plant and is in every sense a natural or physiological rather than a pathological product. While some vegetable gums may originate in this manner and be part of the normal cell content, as in the case of the gums in sugar beet and yeasts, it is now generally agreed that most gums owe their origin to infection of the tissues by some form of micro-organism (A. C. Thaysen and H. J. Bunker, 1927). In some cases the production of gum has been attributed to fungi attacking the plant, these fungi being responsible for enzymes that penetrate the tissues and transform the celluloses and hemicelluloses of the cell wall into gum. This may be the origin of the gum produced in the "gummosis" diseases of certain deciduous and other fruit trees. In other cases, particularly with species of *Acacia*, gum formation has been attributed to bacterial action and it has even been claimed that specific bacteria are capable of producing different kinds of gum, but as yet there is little concrete evidence in support of this. It has even been suggested that a system of inoculating trees to induce a regular and uniform production of gum

might eventually be possible, but no progress has so far been made in this direction.

The bacterial origin of gums was first studied by R. Greig Smith (1902) in Australia and later by J. S. Blunt (1926) and others, in the Sudan. The views of the last mentioned in regard to the bacterial origin of gum arabic in the Sudan are of special interest. He points out that *Acacia senegal* (syn. *A. verek*), the source of the best gum arabic, does not yield gum when in a state of active healthy growth with an abundance of soil moisture and soil nutrients, but only in a state of poor vigour or an unhealthy condition. This may be due to poorness of soil, a common occurrence in the Sudan as the "gum gardens" are often established on land that has become worn out through frequent cultivation of other crops, or to lack of moisture, also a common occurrence, and accentuated by the competition from grasses. It has been found that when gum arabic trees are specially cultivated, and thrive accordingly, or where they are growing near water they remain green most of the year and do not give off gum. When such trees are tapped they appear "to be able to heal quickly and to stave off infection." Callus formation is rapid in such trees. The view is held that the bacterium responsible for the production of gum is always present but whether it is active depends upon the condition of the tree and its environment. If infection were to take place from one tree to another there are many agencies that would cause this. The actual act of tapping as carried out by natives with their implements may cause infection. Ants are common over the wet surface of the wound immediately after tapping. Beetles frequently attack the trees and grazing animals (camels) tear off small branches and twigs.

While some hold the view that the production of gum in Sudan gum arabic trees is due to bacterial agency there are others (D. W. Malcolm 1936) that consider the gum to be a normal product of plant metabolism, produced in response to physiological disturbances induced by drought. They argue that it can hardly be maintained that all, or even the majority of trees yielding gum arabic are unhealthy when *Acacia senegal* has survived and multiplied in spite of being continuously subject to drought and tapping. The real cause of the production of gum in Acacias and many other trees must therefore remain uncertain for the present.

The origin of gum tragacanth and some of the allied gums is of a fundamentally different nature from that of the Acacia gums. True gum tragacanth (*Astragalus* spp.) is produced inside the plant by the transformation of the cell walls and adjacent layers of the medullary rays and the pith into gum. This readily absorbs water causing it to swell and exert pressure on the surrounding tissue. With the consequence that eventually it oozes from the stem of its own accord or as a result of injury or deliberate wounding. The pressure may be so great that a piece or strip of gum 2 cms. long may be exuded in as short a period as half an hour from longitudinal incisions, as in tapping. The gum often contains starch grains in appreciable quantity which were present in the original cells. In this respect the gum differs markedly from the Acacia gums. Little is known of the factors that cause the original gummosis of the cell walls, although fire may act as a stimulus. The rapidity with which the gum exudes determines its shape and to some extent its colour.