Notes on Wild Coffea arabica from Southwestern Ethiopia, with some Historical Considerations

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Introduction

The origin and history of cultivated plants offer tantalizing problems for investigation, particularly to ethnobotanists and plant taxonomists. Plants such as maize, soy bean, sesame, the common garden bean, sweet potato, common potato, and some others have been so altered by man's influence that the wild progenitors often are extremely difficult to determine; in fact, they may no longer exist at all. Many botanists, unfortunately, are loath to collect cultivated plants, which is a pity; and for this reason alone, the progenitors of some cultivated plants remain undocumented and unstudied.

A plant long cultivated and still far from being adequately documented from the wild is the Arabica coffee plant, *Coffea arabica* L. Legend rather than fact still surrounds the details of origin and natural distribution of this plant, although with some intensive field work in Ethiopia, the question of nativity may not be too difficult to resolve.

Various travelers, writers, and others long have suggested that the Arabica coffee plant is indigenous to Ethiopia. Lack of factual data on the wild plant is all the more remarkable, especially in view of the long and sometimes tedious history of Arabica coffee as a product of first importance in world commerce. Of interest is a recent report by the Food and Agricultural Organization of the United Nations (FAO, 1961), which states that "the value of world coffee exports . . . in the fifties was the most valuable single agricultural commodity in world trade, just ahead of raw cotton, raw wool, and wheat."

In 1961–62, for nearly four months, I visited Ethiopia partly to collect and to study the coffee plant which Sylvain (1955) and Strenge (1956) found growing spontaneously in the verdant, evergreen, montane rain-forests of the southwestern part of that country. The present account is a progress report on my collecting trip, with some other data which bear on the history, origin, and modern dispersal of this highly interesting plant. Prior to my visit to Ethiopia, herbarium specimens of the coffee plant from rain-forest areas of the country were unavailable for study.

The documented history of *C. arabica* is associated almost entirely with cultivated plants grown in Yemen for perhaps as long as 700 years (Chevalier, 1929), and with plants distributed from Yemen to Java and to Holland in the late 17th Century and to the New World in the early part of the 18th Century. Now, *C. arabica* is grown as a commercial crop in about 80 countries.

After investigating the early history of botanical exploration in Ethiopia, it was evident that documentation of wild *C. arabica* has eluded botanists in the past for reasons best associated with the geographic and political history of the country.

Current interest in documenting the wild phase of *C. arabica* centers in southwestern Ethiopia, mainly in the provinces of Illubabor and Kaffa, where the coffee plant is abundant in rain-forest areas visited by the writer. Apart from the desire to document the wild plant botanically, a practical need exists to introduce germ plasm from the wild for use in coffee breeding research, especially material resistant to the coffee rust fungus (*Hemileia vastatrix*). Coexistence of the

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coffee rust fungus and the coffee plant in rain-forests of Ethiopia is regarded as significant to the question of nativity and modern dispersal of the Arabica coffee plant. Populations of *C. arabica* in southwestern Ethiopia barely have been tapped as a source of new germ plasm, so that exploration has really only begun.

Taxonomy of Coffea

Coffea, a tropical woody genus of the Rubiaceae, established by Linnaeus (1737), consists of 40 to 70 species confined to Africa, Madagascar, the Mascarene Islands, and Indomalaysia.

Auguste Chevalier was the last great authority on the taxonomy of Coffea. His monograph, "Les Caféiers du Globe," completed before World War II, was published in 1947. This synopsis enumerates 66 species, four-fifths from Africa, Madagascar, and the Mascarene Islands, and one-fifth from southern Asia, divided among four sections: (1) *Eucoffea,* the rain-forest taxa of tropical Africa; (2) *Paracoffea,* the Asian taxa; (3) *Argocoffea,* the savanna taxa south of the African rain-forest belt; (4) *Mascarocoffea,* the taxa of Madagascar and the Mascarene Islands.

Species of the section *Eucoffea,* typified by *C. arabica,* are confined to Ethiopia and the rain-forest belt of the Congo River drainage basin of central Africa and rain-forest areas of West Africa. The Arabica coffee plant contributes about 75% and *C. canephora* Pierre ex Froehn., the so-called robusta coffee plant, about 25% of the world supply of coffee. Two other African rain-forest species, *C. liberica* Bull ex Hiern and *C. dewevrei* De Wild. & Dur., contribute insignificant amounts of commercial coffee, mostly to the Scandanavian market. Other members of the section *Eucoffea* and some species in the other sections reportedly are used locally.

Wellman's (1961) book "Coffee: Botany, Cultivation, and Utilization," although primarily a literature survey, makes an admirable contribution in pointing out the most urgent problems in modern coffee research with suggestions for improvement in areas long neglected, not the least of which is the taxonomy of wild coffee. Traditionally, problems in coffee research have largely been tied to the cultivation and disease problems of the coffee plant, mainly of *C. arabica,* and the economic aspects associated with marketing of the fruit for the drink. Wellman correctly appeals for a concerted effort to study the taxonomy of wild species of *Coffea, C. arabica* in particular, because of its ever important role as the leading crop species of coffee.

Mostly, coffee research is tied to the Arabica coffee plant, a development which has been a saga of our times, beginning about 1600 when small shipments of coffee from Yemen began to appear in western Europe. As compared with research on temperate crop plants, crops grown in the tropics receive far too little attention from specialists, especially in the area of taxonomy. Wellman, like many others, is cognizant that the wild phase of *C. arabica* is found in Ethiopia but that "the true wild range of this species has still to be fully investigated botanically, and understood horticulturally. It needs serious study in comparison with other species." As a pathologist, Wellman knows only too well the Hemileia rust disease problem and the serious need to collect new germ plasm of *C. arabica* from Ethiopia.

A new monograph of *Coffea* based upon field, garden, and laboratory studies is much needed, to define the limits of the genus through a careful evaluation of satellite "genera" which now complicate the taxonomy of this complex.

Some Biologic Aspects of the Arabica Coffee Plant

In several respects, *C. arabica,* Linnaean type species and best known member of the genus, manifests characteristics which are unique among the known taxa of *Coffea.*

The type specimen of *C. arabica* in the Linnaean herbarium in London clearly typifies the plant found by me in the rain-forests of Ethiopia. Although the Linnaean specimen marked "India," presumably designates the country of origin, in Species Plantarum (1753), Linnaeus clearly regarded Arabia as the native habitat of the plant. In the 18th Century, various authors regarded Ethiopia as the country of origin of *C. arabica,* but no authentic specimens were available to Linnaeus. It is clear to the writer that the cultivated phase of *C. arab-*

ica, long confined to Yemen and then spread to other parts of the world, and the spontaneous rain-forest phase of the plant in Ethiopia, taxonomically, are inseparable. Biologically, the Arabica coffee plant differs in several significant aspects from other species of the genus.

The Arabica coffee plant has been studied intensively by numerous investigators from material cultivated in Brazil, India, Java, and other areas, but the Ethiopian phase of the plant remains basically unstudied. Some known facts about the plant are worth enumerating. For example, *C. arabica* is the only known allopolyploid, autogamous species of the genus. All other known taxa of *Coffea* are diploid and outcrossing (allogamous). In its distribution, *C. arabica* is apparently allopatric and isolated on the Ethiopian plateau, although the total distribution of the plant has yet to be fully determined. The closest relatives occur in rain-forests of the Sudan, some 400 miles to the southwest, across the valley of the White Nile River.

Morphologically, *C. arabica* most closely resembles the diploid *C. congensis* Froehn., a species endemic to islands in the Congo River and some of its tributaries, and *C. eugenioides* S. Moore, a species more widespread in east-central tropical Africa.

Bouharmont (1959) in a cytological survey of 15 taxa of *Coffea* found that all were diploid, $2n=22$, except *C. arabica*, $2n=44$. Carvalho in Brazil (personal communication) confirms that *C. canephora* (robusta coffee), *C. dewevrei, C. congensis, C. liberica, C. eugenioides, C. stenophylla* G. Don, and *C. racemosa* Lour. are diploid, self-incompatible (allogamous) taxa.

Genetic studies by Krug and Carvalho (1951) show that *C. arabica* is an allotetraploid, facultatively self-fertilized plant. This species exhibits the only known example of ploidy in *Coffea*. Carvalho (1952) confirms that *C. arabica* is an allotetraploid from a study of mutant haploid progenies of the plant in Brazil. Franco (1939) reports 22, 33, 55, 66, and 88-chromosome races in *C. arabica.*

Narasimhaswamy (1962) suggests that *C. congensis* and *C. eugenioides* possibly are the ancestral parents of *C. arabica.* More recently, Narasimhaswamy and Vishveshwara report (unpublished) on the discovery of a tetraploid sucker that strongly resembles *C. arabica* on a plant of an F_1 cross of *C. eugenioides* × *C. excelsa.* Ploidy in *C. arabica* is one aspect about the plant yet to be explained. One cannot rule out that *C. arabica* may actually have been derived as an allotetraploid from parents now extinct.

Stebbins (personal communication) suggests that a search be made for a diploid 'race' of *C. arabica* in rain-forests of Ethiopia, since such a race could be helpful in explaining the origin of allopolyploidy in this plant. The situation in *C. arabica* may be compared with "a good many 'species' as recognized by taxonomists before cytological studies were made, such as *Hordeum* 'nodosum,' *Madia gracilis, Malacothrix clevelandii, Microseris* spp., which contain a diploid 'race' and a tetraploid or other polyploid 'race,' the latter being actually an allopolyploid species derived from a hybrid between the diploid and some completely different species."

Facultative autogamy and the capacity to produce homozygous recessive mutations are well established attributes of *C. arabica,* as all coffee planters and others who have worked with the plant know. Biologically, these traits are extremely advantageous in allowing high yielding clones to be readily propagated nearly true from seed. Stebbins (1950, 1957) indicates this is the normal situation in autogamous species, such as the common garden bean (*Phaseolus vulgaris*), lima bean (*P. lunatus*), *Bromus carinatus, Ophrys apifera,* snapdragon (*Antirrhinum majus*), *Gossypium* (allopolyploid species). The same authority suggests that "self-fertilizers have been the victims of an unlucky accident. Through acquiring chance mutations, they have lost their capacity for cross-fertilization. A few genotypes from the original heterozygous populations have managed to survive and remain healthy despite the usually deleterious effects of inbreeding, but these have sacrificed their capacity for evolutionary change, and are 'dead ends' of evolution which will become extinct if in the future they become subjected to radical changes in the environment." Evidence from studies on *Amsinckia, Antirrhinum, Senecio, Crepis,* and other genera shows that plants regularly self-fertilized are derived most

probably from cross-pollinating ancestors (Stebbins, *l.c.*). In *C. arabica,* the mechanism pollination may not be significantly different from known examples in other plants, but the details have not been sufficiently studied.

Krug and Carvalho (1951), working at the Instituto Agronômico do Estado, Campinas, found that most plants of *C. arabica* cultivated in Brazil fall probably into two genetic races or groups: Bourbon and Typica. The mutation *C. arabica* (Bourbon) is a double recessive normally carrying the complement (tt). Bourbon gives rise to a host of highly productive and superior clones which come nearly true from seed and are often named. Many Bourbon mutants are preferred by coffee planters over Typica mutations.

The mutation *C. arabica* (Typica) carries the dominant alleles (TT). Among coffee geneticists, mutations of Typica are regarded as primitive or being more closely allied to the wild progenitor from Ethiopia. One would assume that in cultivated material, any plant not a Bourbon is a Typica plant. The mutation Typica, however, has never been properly equated with the wild plant in Ethiopia, so it is not too clear just what is meant by Typica.

Elite clones derived from the Bourbon mutation, such as 'Caturra', 'Semperflorens', and 'Laurina', are considered to be superior commercially to the cultivars, 'Maragogipe', 'Cera', 'Goiaba', 'Calycanthema', and some others derived from the Typica mutation. In their monograph, Krug, Mendes, and Carvalho (1939) described 24 genetic mutants of *C. arabica* from Brazil. According to Carvalho (personal communication), self-fertility occurs in 83% to 95% of populations of *C. arabica* grown in Brazil. The homozygous condition is expressed in the relatively high incidence of recessive mutations which occur in cultivated *C. arabica.* By comparison, observations on the wild phase of *C. arabica* grown at the Agricultural and Technical School at Jimma in Ethiopia indicates that self-fertility there occurs in only 40% to 60% of the plants. The strongly heterozygous condition in populations of *C. arabica* in Ethiopia is to be expected if, indeed, the plant has spread from this geographic center of origin.

Some Geographic Features of Ethiopia

Geographically, Ethiopia is unique among the land areas of Africa. The country is located on the Horn of Africa and extends from about latitude 3°32′ to 18° north of the equator. In size, the country approximates Texas, Oklahoma, and Kansas combined. The heart land, which covers nearly two-thirds of the country, is a high plateau with a mean altitude of 7,000 to 8,000 feet. Mt. Ras Dashan, at an altitude of 15,154 feet, is the fourth highest mountain in Africa. The Great Rift Valley bisects the country in a northeasterly direction from Lake Rudolf on the southwest to the Danakil Depression in the northeast near the Red Sea. As the lowest sink in Africa, the Danakil Depression lies at 380 feet below sea level at Lake Assalé.

The high plateau of Ethiopia is largely treeless, except for limited areas of forest in canyons and river valleys. A belt of montane rain-forest is limited mostly to the provinces of Kaffa and Illubabor in the southwest and to some areas of Sidamo-Borana and Gamu-Gofa in southern Ethiopia. The climate is well suited to cultivation of temperate crops throughout the plateau area. Small grain and pulse crops predominate. Excessively hot regions are confined mainly to a narrow peripheral belt of the country and to deep valleys. In some northern areas of the country, the Arabica coffee plant has been cultivated commercially for about 100 years, especially on the Zeghie peninsula and islands of Lake Tana and in the Chercher mountains of Harar province.

Breitenbach (1961) divides Ethiopia into three climatic zones: (a) " 'Kolla'—hot lowlands, in altitudes below 1400 to 1800 m, with an average temperature of 20 to 29°C.; (b) 'Woina Dega'—temperate highlands, in altitudes from 1400-1800 to 2400-2600 m, with an average temperature of 16 to 20°C.; (c) 'Dega'—cold mountains, in altitudes above 2400 to 2600 m, with an average temperature of 10 to 16°C."

Simoons (1960) suggests that Ethiopia "through most of history has remained a land seldom visited and little known by western scholars. The meagerness of our rather

recently acquired knowledge of Ethiopia is not surprising when we consider the difficulties that visitors in the past underwent to gain access to the mountain heart of the country. European travelers, after a long sea journey, had to pass through coastal lowland areas controlled by Islamized tribesmen who regarded Christians with distrust, contempt, and often hostility. Once in the cool highland, travelers were often troubled and hindered in their work by illness in the new environment. In addition, they were hampered by the reserve and suspicion of the conservative mountain people, especially during the times of anarchy which were so common in Ethiopia's turbulent past. The best early European accounts of Ethiopia were written by a handful of sturdy, intrepid, and highly motivated men, usually priests, representatives of European governments, or adventurers of one sort or another." This lucid description gives an insight into the kind of situation which has prevented the Arabica coffee plant from being documented through most of history.

Ullendorf (1960) indicated that entry into southern Ethiopia, anytime from the beginning of the 17th Century to the beginning of the 20th Century, was virtually impossible for Europeans. From 1632–33, when the last Jesuit priests left Ethiopia, until the beginning of the present century, all southern areas of the country were unvisited by Europeans. Thus, the rain-forest phase of *C. arabica* was missed by all 18th and 19th Century botanical collectors from Europe. As mentioned previously, the coffee plant found in northern Ethiopia is not wild in that area.

Strenge (1956) illustrates the difficulty of visiting areas of Kaffa province some 60 or more years ago, before the overthrow of the Kingdom of Kaffa by the Emperor Menelik II in 1897. Previously, Kaffa was an independent kingdom, which closed its borders almost hermetically against the surrounding provinces of the Ethiopian Empire.

Rain-forest Habitat of *C. arabica* in Southwestern Ethiopia

Until relatively recently, the southwestern provinces of Ethiopia were botanically unknown, and the existence of rain-forest in these areas was not generally known among botanists. Prior to the Italian occupation of Ethiopia, the rain-forests of the country had not been collected. A few Italian botanists made collections during the occupation period (1935–41) and recorded the cultivated phase of the Arabica coffee plant. Since that time, one or two collections have been made by Dr. H. F. Mooney,[2] an Irish forest officer, who, over the past decade has collected extensively in various parts of the rain-forests. Since most botanical collectors inherently avoid cultivated plants, it is fair to assume that the few collectors who have visited the rain-forests of Ethiopia believed that *C. arabica* found in the area was of cultivated origin. Although travel into most areas must still be done on foot, access is possible by air at several points where coffee is transported to market by this method.

Logan (1946), in an interesting account on the forests of central and southern Ethiopia, assigned areas of southwesern Ethiopia to the tropical upper montane rain-forest. The Vegetation Map of Africa (A. E. T. F. A. T., 1958) assigns the same association as montane evergreen forest, a formation which in Africa is unique to the Ethiopian plateau.

Rain-forests are most extensively developed in Kaffa and Illubabor provinces with outlying areas in Wollega, Sidamo-Borana, and Gamu-Gofa. The total area of rain-forest is still unmapped. In altitude, the rain-forest ranges from approximately 3000 to over 6000 feet elevation. Precipitation in rain-forests varies from about 50 to about 90 inches, more or less evenly distributed, with the highest amount falling from May to September. At Bonga in Kaffa, records at the Sudan Interior Mission kept since 1953 indicate an average annual rainfall of 68 to 70 inches with no month rainless.

The Ethiopian rain-forest consists of four stories of vegetation, three woody—emergents, canopy, and shrub—plus an herbaceous layer. The Arabica coffee plant is a component of the shrub understory.

Geographically, the Ethiopian rain-forest is disjunct from the broad evergreen forest belt of the Congo basin by the valley of the White Nile River.

[2] Deceased, 1964.

Yemen—Primary Dispersal Center of Cultivated *C. arabica*

The people of southern Arabia, according to some historians, learned to brew coffee from the Persians, but documentary evidence on this point is not clearly established. An early account of the coffee plant in English (Ellis 1774) is of interest: "Schehabeddin Ben, an Arabian author of the ninth century of the Hegira, or fifteenth of the Christians, attributes to Gemaleddin, mufti of Aden, a city of Arabia Felix, who was nearly his contemporary, the first introduction into that country, of drinking coffee. He tells us, that Gemaleddin, having occasion to travel into Persia, during his abode there, saw some of his countrymen drinking coffee, which at that time he did not much attend to etc. . . ." No evidence exists that *C. arabica* ever was cultivated in old Persia, nor is the plant grown there today.

In Arabic, "Kahwa" is the word for coffee, the derivation of which is uncertain. In French, the word "Café" is derived from the Turkish "Kahveh," and the English word "Coffee" obviously is derived from the same source. In Ethiopia, "Coffee," the beverage, is called "bun" or "buna," a word of Arabic origin, meaning wine.

According to Chevalier (1929), the Arabica coffee plant was cultivated on terraces in Yemen for many centuries before it was known outside of that country. Gradually, the plant spread from this locus to other parts of the world. As the plant became known in Europe, at the end of the 17th Century, *C. arabica* was thought to be native of Yemen. Linnaeus (1753) coined the name *C. arabica* for a plant that he believed was native of Arabia Felix, a political division of the southern Arabian peninsula consisting of Yemen, Hadramaut, Oman, and the Hasa tract. Actually, the plant is grown only in Yemen. The Ethiopian phase of *C. arabica* was unknown to Linnaeus, although there were conflicting reports even in the 18th Century that the coffee plant was probably wild in Ethiopia.

Perhaps few countries of the world have been more remote and less visited by Europeans than parts of the Arabian Peninsula, and Yemen still is infrequently visited by outsiders. The country long has been known as the source of Mocha coffee, which for centuries was exported from the port of Mocha. Mountains of the interior rise to over 10,000 feet and support groves of coffee in areas between 4000 and 7000 feet. Coffee from Yemen first appeared in coffee houses of Cairo about 1510. By the middle of the 1600's, coffee houses had reached England.

Relatively little has been published about the elite clones of *C. arabica* grown in Yemen, but the source of the material now grown there almost certainly originated in Ethiopia. Reis (1914) lists 10 cultivars (varieties) found growing in the country. Reis and Bardey (1914) indicate that Arabica coffee plants in Yemen are grown on terraces and irrigated from wells. Sylvain (1956), as an FAO coffee specialist, visited Yemen to make observations on cultural practices and found six named clones in cultivation.

Yemen is the source of the genetic stock of *C. arabica* now grown in Brazil and other parts of Latin America, Kenya, India, Java, and in other areas where the plant is cultivated. From Yemen, the Arabica coffee plant was taken to Java, India, and Ceylon in the late 17th and early 18th Centuries. This was a triumph for the Dutch, especially since Yemenese planters guarded their plants jealously. Once out of Yemen, the coffee plant spread rapidly to other parts of the world. About 1715, *C. arabica* was introduced to Bourbon, now Réunion, a small French island off the east coast of Madagascar, where the highly productive *C. arabica* (Bourbon) was discovered as a mutant seedling. In the New World, the coffee industry is said to have been established from a single plant of *C. arabica* introduced with difficulty to Martinique from the Jardin des Plantes in Paris about 1720 as a legacy of King Louis XIV.

The early introduction of *C. arabica* into Yemen may well have been part of an exchange of people and plant products between the Arabian peninsula and Ethiopia sometime after 575 A. D. (Wellman, 1961). Early Arab invasions are a significant part of Ethiopian history, and the existence of a Moslem area in Kaffa province today is worth noting in this respect.

No evidence exists to show that *C. arabica* is now or ever has been wild in Yemen, at least since the end of the Pleistocene. Fossil material of the plant is unknown.

Ethiopia—Dispersal Center of Wild *C. arabica*

From time to time, authors and travelers reported that *C. arabica* undoubtedly was a native plant of Ethiopia. Schehabeddin Ben, 15th Century author (Ellis, 1774), writes that coffee had been drunk in Ethiopia from time immemorial. This conflicts with modern reports from Ethiopia, that coffee was not used as a beverage in that country until relatively recently. In some parts of the country, the pulp of the fruit is still used to prepare a kind of cake.

In the 16th and early 17th Centuries, the Portuguese maintained an embassy in Ethiopia, the only European power with diplomatic privileges at that time. So far as I am aware, the Portuguese left Ethiopia without contributing any knowledge concerning the coffee plant.

Botanical exploration in Ethiopia began with James Bruce, intrepid Scottish traveler-naturalist, first and only European to collect botanical specimens in Ethiopia in the 18th Century. Bruce dwelt for five years (1768–1773) in northern Ethiopia, mostly at Gondar north of Lake Tana. In his now historic travels, Bruce (1790) mentions the coffee plant, but no herbarium specimens to document the report are known to exist.

Richard Quartin-Dillon and Antonio Petit collected the first herbarium specimens of *C. arabica* from cultivated plants growing in northern Ethiopia in the 1830's. A. Richard in his "Tentamen Flora Abyssinicae" (1848–51), prepared the first full description of *C. arabica* based on collections of Quartin-Dillon and Petit. Between 1837 and 1863, A. W. Schimper collected widely in northern Ethiopia, and on several occasions he collected the Arabica coffee plant from cultivated material.

During the Italian occupation of Ethiopia (1935–41), various Italian botanists visited Ethiopia and collected plants in the rain-forests in the southwestern provinces of the country. Specimens of *C. arabica* collected in the forest areas are from cultivated plants.

Cifferi (1940) lists the principal selections of *C. arabica* grown in northern Ethiopia at this period without including data on the rain-forest phase of the species found in southwestern Ethiopia.

More than 100 seed introductions of *C. arabica* have been received by the United States Department of Agriculture over the past 10 to 12 years from FAO and US/AID coffee specialists working in Ethiopia. Many of these collections were obtained from rain-forests, but voucher herbarium specimens to document the original seed samples were not prepared.

Sylvain (1955, 1958), working with *C. arabica* in Ethiopia, compiled a useful descriptive list of named *C. arabica* clones derived from indigenous Ethiopian coffee plants. The suggestion by Sylvain that the Arabica coffee plant is wild in the essentially treeless parts of northern Ethiopia is highly improbable. The evergreen, coriaceous drip-tip leaves of *C. arabica* would associate this plant more clearly with rain-forest than with arid, treeless areas of northern Ethiopia. The adaptability of the Arabian coffee plant to full sun in some areas where it is cultivated (viz. northern Ethiopia, Yemen, Brazil, and Kenya) is, however, one of the more remarkable adaptive aspects of this basically heliophobic plant.

Chevalier (1947) regards *C. arabica* var. *abyssinica* Chev. from northern Ethiopia as representing the wild phase of the plant. Actually, the specimens seen by Chevalier represent cultivated plants of unknown origin. The contention that the Arabica coffee plant is wild in the arid savanna country adjacent to the Atbara River in the northwestern part of Ethiopia or in any other northern area of the country is highly doubtful. Areas adjacent to the Sobat River of Sudan are said to support wild *C. arabica,* but this is probably incorrect. According to H. F. Mooney (personal communication), the Arabica coffee plant is abundant in the rain-forest near the Baro River, the name of the Sobat in Ethiopia. Chevalier probably is correct in pointing to the rain-forest areas between the Gojeb and Omo rivers as supporting wild plants of *C. arabica.*

Collections of *C. arabica* from Southwestern Ethiopia, 1961–62

My collecting was limited to parts of Kaffa, Illubabor, Wollega, and Shoa provinces. In Kaffa and Illubabor, the plant is often abundant as a component of the rain-

Fig. 1. Areas covered by diagonal lines in southwestern Ethiopia show, generally, the confines of the montane rain-forest, where *C. arabica* occurs as a spontaneous plant. Note areas marked Zeghie on Lake Tana in Gojjam province and the Chercher Mts. in Harar province, where *C. arabica* is cultivated extensively. Note also the Boma Plateau in southeastern Sudan and Mt. Marsabit in northern Kenya, localities where *C. arabica* may possibly be wild.

forest flora. At Ghimbie in western Wollega province, coffee is extensively grown in gallery forest. At Walkitte, in Shoa province, along the Jimma road, *C. arabica* is cultivated in full sun.

The maps (Figs. 1–4) show the areas visited.

Field Observations

7754[3]—Bada Buna (Kaffa Province). Dec. 19. A well known station for semi-domesticated coffee, located 6 mi. NE. of Jimma, about 5400 ft. alt., 7°40′ N., 36°52′ E. Rainfall averages about 75 inches per year, but

[3] Author's field number.

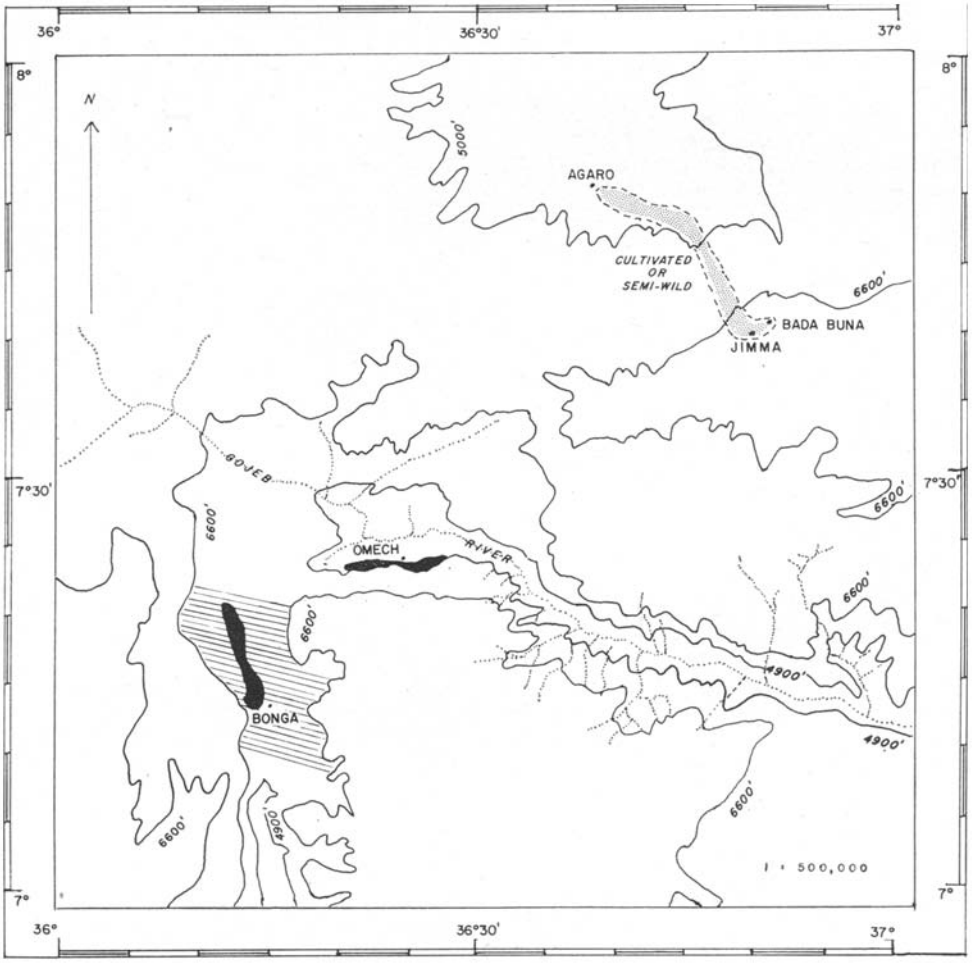

Fig. 2. Kaffa province. Areas in black show localities where collections of *C. arabica* were made. Slant lines show rain-forests, near Bonga, not visited where wild coffee plants probably occur. The northern limit of gallery forest is found between Jimma and Agaro.

the area supports only isolated segments of rain-forest on north hillsides or as gallery forests along streams. The Arabica coffee plant was introduced to the Bada Buna forest ("buna" is the Ethiopian name for coffee) many years ago, where it now thrives and is naturalized. The only visible attempt to cultivate the coffee plant in this locality consists of keeping the jungle cover from swamping the coffee bushes. Coffee plants are spaced at intervals of 3 to 6 feet underneath indigenous trees, which include *Celtis africana* (Ulmaceae), *Pygeum africanum* (Rosaceae), *Rothmannia urcelliformis* (Rubiaceae), *Syzygium guineense* (Myrtaceae), *Polyscias fulva* (Araliaceae), *Oxyanthus speciosus* (Rubiaceae), *Croton macrostachys* (Euphorbiaceae), *Mimusops kummel* (Sapotaceae), *Schefflera abyssinica* (Araliaceae), *Millettia ferruginea* (Leguminosae), and some others. Common shrubs associated with the coffee plant in the Bada Buna forest are *Maesa lanceolata* (Myrsinaceae), *Galiniera coffeoides* (Rubiaceae), *Ehretia cymosa* (Verbenaceae), *Diphasia danielii* (Rutaceae), and *Acanthus eminens* (Acanthaceae).

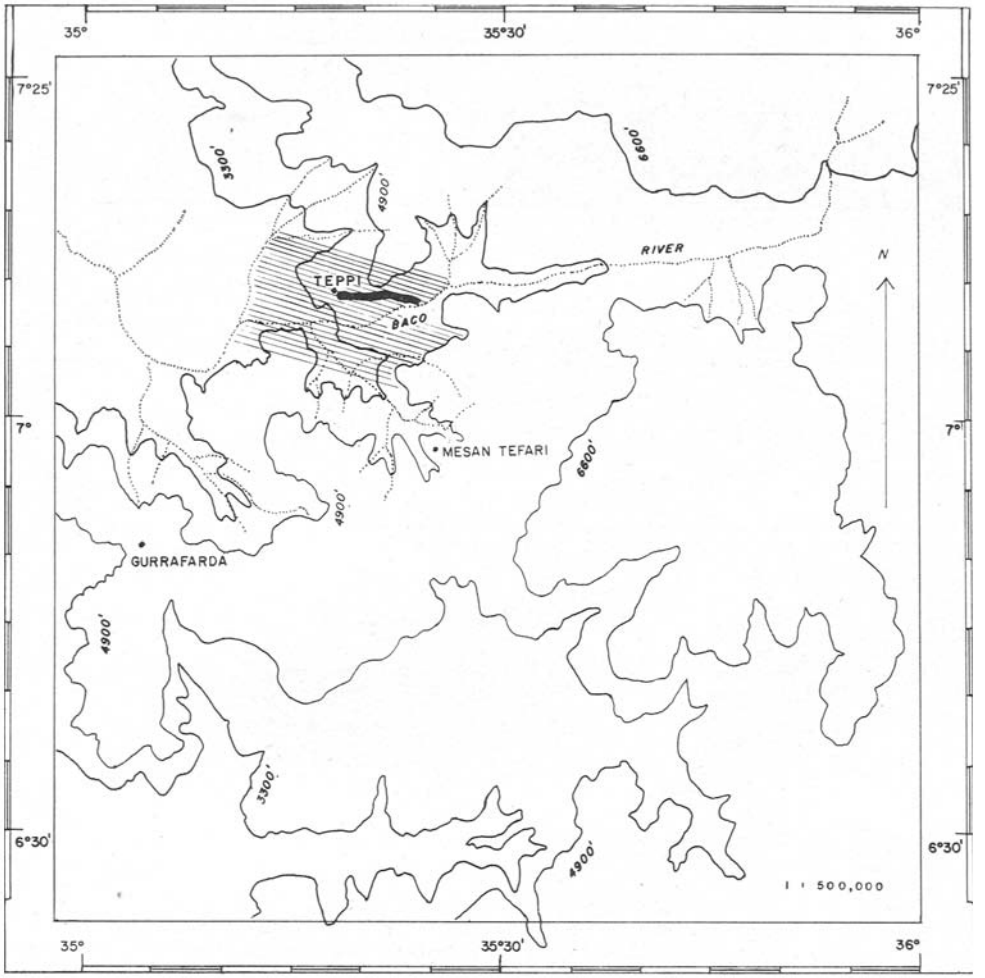

Fig. 3. Kaffa province south of the Baco River and Illubabor province to the north. *C. arabica* was collected in the area shown in solid black. The rain-forest spreads in all directions from this point, south to Mesan Tefari and Gurrafarda.

Coffee plants in the Bada Buna forest have been studied by Mr. Hugh Rouk of the Agricultural and Technical School at Jimma and by Dr. Edgar Anderson (1961), who suggests that two loose complexes exist among semi-domesticated plants growing in the Bada Buna forest.

1. Large, flattish, deep red, small scarred, sharply tapering berries.

2. Small, roundish, orange-red, large-scarred, gently tapering berries. Anderson suggests "there is taxonomically more variation between the coffee bushes than in all the *Coffee arabica* cultivated in the New World." Earlier, figures were presented to show that self-fertility, homozygocity, and the tendency to produce recessive mutations are traits limiting variability in coffee plants growing in Brazil. Indications are that outcrossing in populations of coffee in rain-forest districts of Ethiopia results in greater variability than in coffee plants cultivated in Brazil.

Collections made at Bada Buna show a range of variation in fruit length and width not significantly different from plants col-

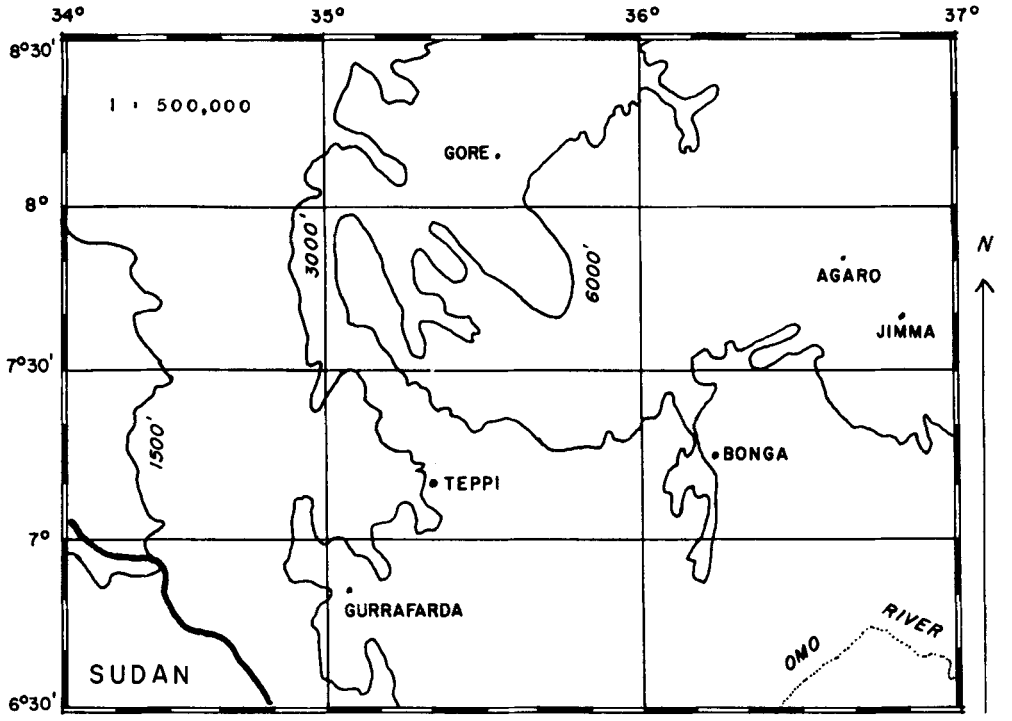

Fig. 4. The distribution of *C. arabica* is limited to areas between the 3000 ft. and 6000 ft. contours.

lected at Bonga and at Teppi (see Table 1).

7817—Jimma (Kaffa province). Dec. 25. About 5 mi. NE. of Jimma, about 5250 ft. alt. Arabica coffee plants are widely cultivated in gallery forest, mostly south and west of Jimma. Seedlings of coffee are planted about 3 ft. apart, which is too close for profitable fruit production. Spread of the plant is accelerated in this area, as it is elsewhere in the forest districts, by monkeys and baboons.

7836—Ghembo (Kaffa province). Dec. 28. A village about 10 mi. N. of Bonga along the Jimma road, about 5100 ft. alt., 7°20′ N., 36°14′ E. The Arabica coffee plant is both cultivated and spontaneous in this area.

7846—Bonga (Kaffa province). Dec. 29. About 5100 ft. alt., 7°14′ N., 36°15′ E. *C. arabica* is abundant in the forest above the Dentcha River; old plants with a trunk diameter of 3 to 5 inches and 20 ft. tall were not uncommon. Associated with the coffee plant in this locality are scattered trees of *Schefflera abyssinica* (Araliaceae), a tree of the canopy layer with a diameter of 3 to 4 ft. Common in the understory shrub vegetation are *Dracaena fragrans* (Liliaceae), a shrub about 8 ft. tall and *Uragoga ciliato-stipulata* (Rubiaceae), a subshrub 12 to 18 inches tall with blue fruit. An herbaceous plant, *Aframomum korarima* (Zingiberaceae), a well known spice plant of Ethiopia, is common in this locality.

7850—Bonga. Dec. 30. The coffee plant is common near Seimens coffee mill, about 6 mi. NW. of the Sudan Interior Mission. At this locality, the number of coffee plants were counted in a measured plot 90 ft. by 75 ft., to determine something concerning the natural abundance of the coffee plant in the Bonga area. Plants in every stage of development were encountered, including germinating seeds and a total of 45 fruit-bearing bushes, each 6 ft. to 15 ft. tall. Commercial planting of seedlings in the uncleared forest is beginning to confuse the pattern of dis-

tribution of the Arabica coffee plant in this region.

7870—Bonga. Jan. 1. A site located 7.5 mi. N. of the village, about 5340 ft. alt. Plants 6 to 15 ft. tall are approximately as abundant in this locality as in several other sites visited in the Bonga district.

7879—Omech (Kaffa province). Jan. 1. Site of a village located on the Jimma-Bonga road, about 4 mi. SW. of the Gojeb River bridge, 7°23′ N., 36°20′ E. A magnificent rain-forest is found on the steep north-facing middle and upper mountain slopes above the village. Giant specimens of *Polyscias fulva* (Araliaceae), a noble tree with ashen grey pillared trunks, impart a cathedral-like character to this forest. Lianas which festoon the trunks of many trees, include *Culcasia scandens* (Araceae), a rampant aroid, and *Gouania longispicata* (Rhamnaceae). One of the minor components of this forest is *C. arabica*. Rarity of the coffee plant may be attributed to altitude, which, at about 6000 ft., is the upper altitudinal limit of this species.

TABLE I

	Fruit Length	Fruit Diameter		Calyx Diameter	Pedicel Length
Buda Buna (Jimma), 7754	11.0-13.5 mm.	Locular 9.0-11.5 mm.	Commisural 7.0-9.5 mm.	1.6-2.7 mm.	3.5-7.0 mm.
Teppi, 8040	12.0-15.0 mm.	10-11 mm.	8-9 mm.	1.6-2.4 mm.	4-5 mm.
Teppi, 8001	12-14 mm. (-16)	10-11 mm.	7-8 mm.	1.6-2.4 mm.	3.5-4.0 mm.
Bonga, 7850	12-15 mm.	10-12 mm.	8-10 mm.	1.6-2.0 mm.	4-6 mm.
Ghimbie (Wollega), 8160	12-14 mm.	10.0-14.5 mm.	8-11 mm.	1.6-2.4 mm.	4.0-5.5 mm.
Jimma (Kaffa), 7817	13-15 mm.	10-11 mm.	-	1.8-2.0 mm.	4-5 mm.
Agaro (Kaffa), 7915	12-14 mm.	9.5-12.0 mm.	8.0-9.5 mm.	1.8-2.8 mm.	3.5-5.0 mm.

FRUIT MEASUREMENTS (DRY) OF C. ARABICA COLLECTED IN VARIOUS LOCALITIES

Fig. 5.*C arabica* in left foreground and in middle of photograph shows fruiting plants in secondary forest near Teppi, Illubabor province. Wild coffee plants are abundant in this area.

7915—Jimma-Agaro (Kaffa Province). Jan. 5. Plantings of Arabica coffee are common in gallery forest under large specimens of *Albizzia schimperiana* (Mimosaceae), about 10 mi. NW. of Jimma along the low road to Agaro, about 5400 ft. alt. Isolated specimen plants of *C. arabica,* 20 ft. tall and about 8 inches in diameter possibly are relict wild plants. It is entirely possible that wild coffee once grew in the gallery forest near Jimma prior to invasion of the area by commercial interests some years ago. One long-time Greek resident at Agaro told me that coffee as a commercial crop dates back about only 40 years in that district, while cultivation of the plant on a major scale dates from about 1950.

7930—Ghembi (Kaffa Province). Jan. 7. Coffee is grown in gallery forest along the Jimma-Agaro road under large specimens of *Albizzia schimperiana,* at about 5360 ft. alt. The coffee harvest is greatly reduced under such conditions because plantings are overcrowded.

8001—Teppi (Illubabor province). Jan. 14. About 5 mi. NW. of Teppi airstrip, 3960 ft. alt., 7°10′ N., 35°18′ E. The village of Teppi (unmarked on any known map) is located in the heart of the rain-forest belt of southwestern Ethiopia. *C. arabica* is abundant in several sites visited. In general, a heavy forest cover characterizes the area. The terrain is of relatively low relief, except for isolated low-lying mountain peaks. Several rivers have dissected the area, but near Teppi the relatively flat land may offer opportunities for modern coffee plantations. An airstrip provides direct service to Jimma. Rainfall of approximately 70 inches is fairly well distributed over the year, although concentrated principally from June to about October. Crop plants are tropical, but this region is not part of the lowland tropics. Cleared land is used for growing grain sorghum and maize, both food staples of the area. Manioc (*Manihot esculenta*) and sesame (*Sesamum*) are grown in village gardens. Around 'tukals' (round thatched houses of the native people) the Ethiopian cabbage, *Brassica carinata* A. Br., is much grown as a source of seed oil for household cooking and for greens in soup. The pulse crops (legumes), teff (*Eragrostis teff*), and other cereal grains widely grown in the high plateau to the north cannot be grown successfully in rain-forest districts.

In the Teppi area, *C. arabica* is grown around most houses, but the main coffee harvest is derived from spontaneous plants in the rain-forest. In this region, *C. arabica* is extremely verdant and often of large size. Plants 25 ft. tall and nearly 1 ft. in diameter at ground level often are swathed in moss, epiphytic orchids and ferns, such as *Playtcerium angolense* and *Microsorium punctatum.*

Coffee as handled for the commercial market in the Teppi area epitomizes the technique of "cultivation" found in forest districts of southwestern Ethiopia. Coffee is now harvested from nearly every available bush throughout rain-forest areas largely from the fact that slightly over 50% of the national product of Ethiopia is derived from the export of Arabica coffee. Collection of fruit from wild coffee plants consists first of exposing the bare earth underneath the bushes. Most of the crop is hand picked, but some fruit falls to the ground, and this, too, is used as part of the harvest; also, the bare

ground provides a seed bed for seedlings which are transplanted to other sites in the forest. By this method, variants that otherwise might never survive are brought into "cultivation." As a crop plant, however, *C. arabica* may have only just emerged on a long path toward "ultimate" domestication, as compared with some other well known domesticated plants long cultivated in Ethiopia, such as teff, sorghum, barley, and the common pea.

8019, 8020—Baco River (Illubabor-Kaffa province border). Jan. 15. The Baco River is one of the tributaries of the Sobat, a sizeable tributary of the White Nile. At an altitude of 3030 ft., the river flows through a V-shaped gorge several hundred feet deep, with dense rain-forest on each side. On the Kaffa, or south bank, the enset plant (*Ensete edule*), the false banana, is wild. On the Illubabor side, plants of *C. arabica* occur about 100 yds. above the river.

8096—Walkitte (Shoa province). Jan. 23. A locality about 80 mi. S. of Addis Ababa, about 5400 ft. alt. 8°15′ N., 37°47′ E. In this region, *C. arabica* is cultivated by the Gurage people in full sun or under plants of enset (*Ensete edule*). Rainfall of about 57 inches per year is concentrated wholly in the short but intense rainy season from June to September. Size of fruit and leaves in some clones of coffee grown here show a close relationship with spontaneous plants found in rain-forest districts to the southwest.

8097—Walkitte. *C. arabica* 'Arore', Jan. 23. The nearly spherical fruit is a distinctive characteristic of this named clone. Nothing found in the wild approached it in size or in shape. When fresh, the fruit averaged 16 mm long by 15 mm wide, with a much darker red pericarp than in other clones cultivated in this locality. A clone of high productivity in full sun.

8098—Walkitte. *C. arabica* 'Chercher', Jan. 23. According to the farmer who grew it, this clone originally came from the Chercher Mountains of Harar Province in eastern Ethiopia. The fruit of this clone averaged relatively longer, about 16 mm long, and narrower, about 11 mm wide, than in wild coffee found in rain-forest districts.

8128—Ghimbie (Wollega province). Jan. 31. Ghimbie, at about 6000 ft. alt., 9°11′ N., 35°50′ E., is a center for cultivated coffee. Here, the plant is cultivated extensively in gallery forest in the vicinity of the town. According to local growers, the planting stock originated from indigenous plants found in rain-forests to the south.

Co-existence of the Coffee Rust Fungus (*Hemileia vastatrix*) and *C. arabica* in Southwestern Ethiopia

In the New World, the coffee rust fungus (*H. vastatrix*) is unknown. However, in the Old World the fungus continues to ravage the Arabica coffee plant in at least 37 countries of the Eastern Hemisphere (Wellman, 1961). The coffee rust fungus is thought to be indigenous to Ethiopia, but now it occurs in nearly all areas of Africa where *C. arabica* is grown, although spread of the rust into areas of Africa outside of Ethiopia is said to be of relatively recent date. In the Eastern Hemisphere, the rust fungus was first detected in Ceylon in 1869 and soon thereafter in Java; within about 20 years, it brought doom to the commercial production of Arabica coffee in these areas. No record exists for the occurrence of the fungus in Yemen, nor is there any record of how the fungus originally got into Ceylon.

Although the coffee rust fungus and the coffee plant occur sympatrically in Ethiopia, the fungus appears not to be a problem in rain-forest districts.

Fungi Collected on *C. arabica* in Rain-forests of Ethiopia

Determinations by J. A. Stevenson, National Fungus Collections, Beltsville, Maryland.

8009—*Hemileia vastatrix* Berk. & Br. Jan. 15. The urediospore stage of the fungus found on *C. arabica* near the Teppi airstrip, Illubabor province, 396° ft. alt., 7°10′N., 35°18′ E. Only the urediospore stage of the fungus is known. Perhaps the aecial stage will turn up in Ethiopia, if, indeed, the fungus is indigenous there.

8014—*Aschersonia goldiana*. Sacc. & Ell. Parasitic on scale insects found on *C. arabica* (see Meyer 8013). Not an uncommon fungus with characteristic yellow spherical

spore areas surrounded by a white halo on the lower leaf surface.

8020—*Aschersonia goldiana,* Sacc. & Ell. On leaves of *C. arabica* found along the Baco River (see Meyer 8019).

Summary

Coffea arabica L., the Arabica coffee plant, long known as a cultivated plant only, is now being documented as a wild plant for the first time. This plant, more especially the beverage coffee, came into prominence soon after the beginning of the 16th Century in Cairo and a little later in Europe. Yemen was the traditional source of Mocha coffee until seeds of the plant were taken to Java at the end of the 17th Century to begin an important industry in that island country.

Traditionally, Ethiopia has been regarded as the center of origin of the Arabica coffee plant, yet authentic records of wild plants based upon documented material are not available in the older collections. On a trip to Ethiopia in 1961–62, I made the first serious attempt to document *C. arabica* from rain-forest areas of the country, where the plant occurs spontaneously in many places. An interpretation of field data tends to show:

(1) That the Arabica coffee plant (*C. arabica*) is abundant as a spontaneous component of the rain-forest between 3000 and 6000 ft. alt. in parts of Kaffa and Illubabor provinces in southwestern Ethiopia.

(2) That modern man's role in the domestication of *C. arabica* in rain-forest districts of Ethiopia may date from relatively recent times. In no way can coffee be considered a refined crop in these districts, as are some food plants of the area, such as sorghum, maize, Ethiopian mustard, and the pulse plants.

(3) That genetic variability in coffee plants in rain-forest districts of Ethiopia probably is much greater than in coffee plants grown in Latin America and in other areas of the world where *C. arabica* is cultivated. Yemen was the major germ plasm center of cultivated Arabica coffee until a decade or two ago. But the coffee plant is not a native of Yemen.

(4) That the coffee rust fungus (*Hemileia vastatrix*) and *C. arabica* appear to coexist harmoniously in rain-forests of Ethiopia, which strengthens the case for Ethiopia as the modern center of dispersal of the Arabian coffee plant.

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