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Influence of Religion on the Spread of Citrus

The religious practices of the Jews helped effect the introduction of citrus to Mediterranean lands.

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When Goethe wrote the famous poem beginning "Kennst du das Land wo die Zitronen blühen?" he presumably referred to Italy. Of course, lemons as well as citrus fruits as a whole are not limited to Italy or even to the Mediterranean basin but grow in areas as widely separated as Japan, India, South Africa, and California. Indeed, while citrus is associated with areas which may be described as of Mediterranean climate, it is practically a newcomer to the Mediterranean itself and was introduced there through what is today the least familiar member of the genus—the citron or *Citrus medica* (*1*). This fruit was the first of its genus to be cultivated intensively in the Fertile Crescent of the ancient Near East —namely, Mesopotamia, Syria, Palestine, and Egypt. It owed its distribution into the Roman Mediterranean to the Jews, for whom the citron had become an object essential for the ritual celebration of the holiday of the Feast of Booths. The history of the citron is to me a striking illustration of the part, far too little recognized, played by religion in transforming the landscape.

The citron, *Citrus medica* var. ethrog Engl. (*2*) (see Figs. 1 and 2) belongs to the subfamily Aurantioideae. The citron tree (see Fig. 3) is a small evergreen with irregular and spreading spiny branches, pale green oval and slightly serrated leaves, wingless petioles, and generally perfect flowers. It produces a fragrant golden oval or oblong fruit 4 to 8 inches long with a knobby skin. The citron's protuberant nipple carries a persistent pistil. While in most citrus trees flowering takes place in the early spring, the citron continues throughout the year to produce flowers in varying degrees of abundance. This absence of a period of dormancy makes it, of all the citrus species, perhaps most susceptible to frost damage and limits the range of its commercial cultivation. The citron is mainly cultivated in coastal sections where frosts are infrequent. The development of fruit in interior sections is often inhibited by high temperatures (see *3*, pp. 42–3, 55, 62).

The tree grows on a great variety of soils, provided that the content of organic matter is satisfactory. Soil texture is the most important characteristic. The tree does best on fine sandy loams, although in Tunisia, perhaps the most important commercial citron area of North Africa, plantings are sometimes made on pure sand (*3*, p. 64; *4*). It is interesting that commercial cultivation of a tree so obviously adapted to the tropical rain forest (because of the absence of devices limiting transpiration or evaporation, lack of a regular dormant period, weak root-hair development, and nearly naked buds) (*3*, p. 51) should today occur overwhelmingly in areas of Mediterranean climates.

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Origin and Spread of Citron

When did the Jew first become acquainted with the citron, or etrog, as he calls it? This is a question which has not yet been conclusively determined and involves the problem of the origin and transmission of the species *Citrus medica*. Nineteenth- and early 20th-century observers, on the whole, concurred in asserting that the citron, lemon, and lime originated on the Himalayan slopes of India and Burma or in the southern part of the Indian peninsula (*5*). There were a few dissident voices, as, for example, E. Bonavia, who came to doubt an Indian origin for the citron when he noted its prevalence on India's western shore, an area which had been most open to foreign influences (*6*). In the 20th century there has been practically unanimous agreement that southwest Asia was the origin of citron, but whether in India or further west in southern Arabia is still a subject of dispute (*7*).

It is surprising that not more attention has been paid to the Arabian peninsula as a possible area of origin of citron, inasmuch as various reports suggest the probability that this area was its native home. Such an authority on citrus as Walter T. Swingle reverses the usual theory that citron spread from India to Media and Persia and then to the Mediterranean by hypothesizing an origin between India and Africa:

"The early advent of the citron in Media and Persia, and subsequent slow penetration into India and China could be explained easily if the citron should prove to be a native of southern Arabia. The bael fruit of India, Aegle Marmelos, has no close relatives in Asia, but three closely allied genera, Aeglopsis, Afraegle, and Balsamocitrus are found in Africa. Citropsis, an African genus of the Near-Citrus fruit trees closely related to the

Asiatic genus Atalantia, has eleven species. It would not be surprising to find midway between India and Africa, in some mountain oasis within the tropical zone in Arabia, the citron growing in a wild state" (*8*).

When did the citron spread from its place of origin—whether this was India or Arabia—to the Fertile Crescent, where the Jew might have found it a part of the regional flora? Traditionally the citron is accepted as the fruit commanded by the Bible for use in the ritual observance of the Feast of Booths, an ancient Hebrew festival originally known as the Feast of Ingathering (see Exodus 23:16; 34:22). Leviticus 23:40 reads: "And you shall take unto yourself on the first day the fruit of a goodly tree, palm branches, foliage of a leafy tree, and willows of the brook, and you shall rejoice before the Lord your God seven days." There is, of course, no reference to the citron here, nor is the etrog mentioned by name anywhere in the Bible. Not until the second century B.C. do we possess ample documentary evidence that the citron was the fruit accepted as "the fruit of a goodly tree." Nonetheless, Jewish religious authority of that period maintained that the citron had always been used and was the original fruit designated by the Bible.

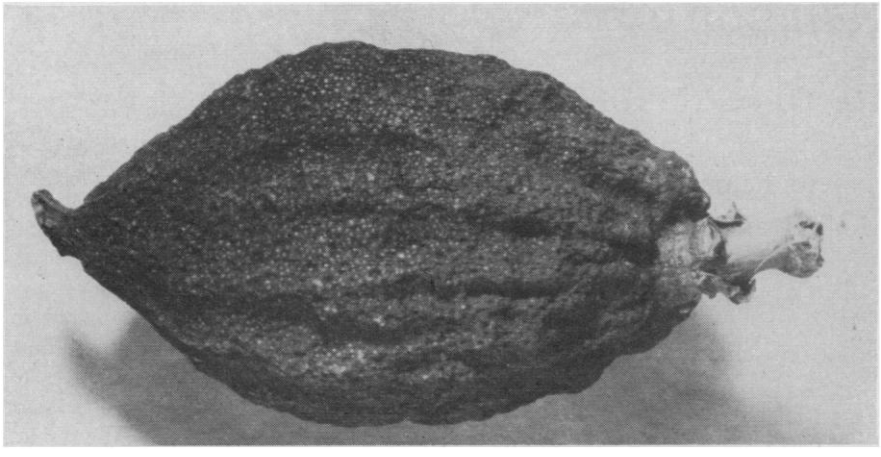

Fig. 1. The citron or etrog. [Frank J. Darmstaedter, Jewish Museum, New York]

Fig. 2. Fruit lying in a silver etrog receptacle (Germany, 18th century). [Frank J. Darmstaedter, Jewish Museum, New York]

This identification of the citron with "the fruit of a goodly tree" commanded at the time of the wanderings in the desert has not gone unchallenged. The argument has been advanced that the Feast of Booths was not celebrated until the time of Ezra and Nehemiah in the fifth century B.C., when the first actual celebration of the feast is described. According to this view, favored by Gallesio, de Candolle, and other authorities, the feast was held then for the first time. Such a theory, of course, presumes a late composition of Leviticus 23:40, since it does not deny the identity of "the fruit of a goodly tree" and the citron but considers that the Jews came in contact with the fruit during the exilic period in Babylonia and brought it back with them to Palestine on their return from the captivity. In the absence of clear proof one way or the other, the first problem is to establish the earliest period at which the citron could have been part of the Levant flora and thus available to the Jews in Palestine.

It is known that in ancient times the lands between the Mediterranean, the Red Sea, and the Indian Ocean were bound together by extensive economic and cultural interchange. Scholars now assert the impossibility of regarding the cultures of the ancient East and Near East as hermetically sealed entities which achieved their flowering independently of the cultural developments in surrounding territories. As early as the fourth millenium B.C. the cultures of Mesopotamia, Syria, Palestine, Egypt, and probably Asia Minor were jointly on the road to civilization, and the contacts were so marked that it may indeed be possible to consider Babylonian and Egyptian civilizations as regional variants of one culture (*9*). Babylonian cylinder seals, pottery types, art motifs, architecture, and early writing all stimulated Egyptian productions of the same nature. Moreover, these contacts were probably not limited to the Fertile Crescent but encompassed the furthermost reaches of the Red Sea. A predynastic ivory showing sailors with a strange craft, which Sir Flinders Petrie interprets as depicting the arrival in Egypt of a ship from Punt (either Somaliland or southern Arabia), is one example of these far-reaching contacts (*10*).

Nor were these contacts limited to the

Fig. 3. Woodcut of branches of a citron tree with fruit. From John Gerard's herbal, *The Historie of Plants* (Printed at London by John Norton, 1597), p. 1278. [W. Hausdorfer, Sullivan Memorial Library, Temple University]

inception of civilization; they continued through the centuries. The Mari Archives, found by a French expedition in 1936, illustrate the freedom of movement in the world of the Fertile Crescent. "Trade was widespread and caravans of merchants were among the commonest sights" (*11*, p. 5). The Biblical picture "of limited movements in the hill country of Palestine, of seasonal migration between the Negeb and Central Palestine, and of easy travel to Mesopotamia and Egypt is, accordingly, so perfectly in accord with conditions in the Middle Bronze Age that historical skepticism is quite unwarranted" (*11*, p. 6). The Bible describes extensive commerce in the tenth century B.C., between Phoenicia, Egypt, southern Arabia, and adjacent regions, as well as with Hittite northern Syria and Cilicia. Elaborate trading expeditions were organized by Solomon and Hiram of Tyre (969–936 B.C.), whose scope embraced the Red Sea, the Indian Ocean, and probably the Mediterranean (Kings I, 9:26; 10:22). This extensive trade was carried on both by sea and by land, land trade having been made possible by the domestication of the camel not long before the 11th century B.C. At the time of Solomon we know that Somaliland and southern Arabia, separated from it by the Red Sea, were considered to be one region. This identification dates back to a period at least as early as the 14th century B.C. (*12*).

We have evidence also of the Egyptians' familiarity with this region. Egyptians traveled from Kosseir to "the divine land" or "the frankincense terraces," terms generally understood to refer to the African shore from Massawa to Somaliland, and to southern Arabia (*13*, pp. 6–9). Punt yielded to the Egyptian kings incense and gold and emeralds (Pliny, xxxvii, 66), and an indication of the closeness of contact is the boast of one traveler of the period of the Middle Kingdom that he had been to Punt 11 times (*13*, p. 7).

We have no certain evidence as to whether the exchanges between these various regions involved the transportation and transplantation of seeds before the 16th century B.C. The first extant record dates back to about 1500 B.C., when Queen Hatshepsut of Egypt imported incense trees "to make for Amon a second Punt in his garden" (*13*, p. 7). Her ships are depicted, in color reliefs, as 30 saplings are brought aboard them in tubs, while the native ruler looks on. We know that trade with Punt continued to the time of Rameses II and Rameses III (*13*, p. 9). Egyptian sailors may also have penetrated into the Persian Gulf, skirting the Arabian coast, inasmuch as they knew the Euphrates, which they called "the reversed waters" because it flows south, while the Nile flows north.

But if Swingle is right in postulating a southern Arabian origin for the citron, and given the fact of both Egyptian and Palestinian contacts with this region, including the actual evidence of transplantation of trees, the likelihood is great that the citron was transmitted from its place of origin in southern Arabia to Egypt and Palestine in the course of trade. Significant in this light is mention in the Mishna (Succah 3:6) and the Talmud (T. Yerushalmi, Succah, p. 53b and T. Bavli, Succah, p. 36a) of an Ethiopian citron as distinct from the Palestinian. This was probably the Yemenite citron, which has been introduced into Israel in recent years by members of the Yemenite community, a community which was, in ancient times, at various periods subject to Ethiopian or Somali rule.

It is reasonable to believe, then, that the citron was transported from southern Arabia and spread throughout the Fertile Crescent, in which areas favorable to its growth abound. Hospitable habitats exist, for example, along the Nile and in Mesopotamia, where the high moisture requirements of the tree can be amply satisfied and where killing frosts are an exception. There is, moreover, evidence for the presence of citron in Mesopotamia in Assyrian times, when what is most probably a citron is depicted on an Assyrian sculpture (*14*). Seeds of *Citrus medica* were found in southern Mesopotamia in the ruins of old Nippur (*15*), and although precise dating is impossible, from their location in the ruins it is evident that they must date back to the fourth millenium B.C. In the second millenium we find the citron referred to frequently in Assyrian medical texts as *"iltakku,"* which corresponds to the Hebrew "etrog"—the citron. Archeological evidence in the form of a model of a citron indicates its presence in Egypt in the 12th century B.C. (*16*).

Citron as "Fruit of a Goodly Tree"

If the citron spread from southern Arabia through the ancient channels of trade to Mesopotamia, Media, Persia, and India, and northwest to Egypt and adjacent countries, it is quite possible that the citron existed in the better-watered coastal plains of the Levant coast in the period of the early kings of Judah and Israel. It may be, too, that its religious significance to the Jews dates back to that period, if not to an era even more remote. Should the citron, on the other hand, not have been part of the Levant flora, the Jews would have made its acquaintance at the latest during their exile in Mesopotamia in the sixth century B.C.

While the citron's presence does not in itself constitute proof that this was the fruit referred to in the Biblical commandment, the likelihood is enhanced by the fact that the citron tree was considered holy in other cultures, including those of India and China. Contact between the Mediterranean shore lands and the Indian realm extended to the religious and spiritual field. The Indian god Kuerva is usually portrayed carrying a citron or lemon and a variety of citron which has five lobes is called "Buddha's hand" by the Chinese (*17*). The golden bullock around which the Jews danced in the wilderness (Exodus 32) and the golden bulls to which temples were built in the reign of Jeroboam (Kings I, 12:28–33) correspond to or are derived from the storm-god familiar

throughout southwestern Asia from 3000 B.C. to the fourth century A.D. The storm-god was represented standing upon a bull, or merely the bull was shown, with the storm-god understood to be invisibly upon it (*18*).

Further supporting evidence for an early identification of the citron with the "fruit of a goodly tree" is the later insistence of the rabbis that the citron is, beyond question, the tree designated. The arguments are primarily those of rabbis living in the second century A.D., but they represent a long oral tradition. Rabbinical Judaism as a whole has never doubted the antiquity and authenticity of the citron, and rabbinic arguments maintaining it appear to be advanced to prevent the Feast of Booths from falling prey to the influences of syncretism—a danger to which this holiday was particularly subject in view of the many pagan parallels. The extent of the danger is well illustrated by the interpretation Plutarch managed to put upon the Feast of Booths. According to him the holiday was "openly dedicated to Bacchus, for they have a feast amongst them called *Cratephora* from carrying palm trees, and *Thyrsophoria,* when they enter into the Temple carrying thyrsi; what they do within I know not, but it is very probable that they perform the rites of Bacchus" (*19*).

Other cults of the Near East used similar objects, such as pine cones, in their celebration; the rabbis' arguments were designed to prove why the citron, and only the citron, could have been meant and should be used at the time of their writing.

Typical of rabbinic arguments for the citron was the insistence that only in the case of this fruit were both fruit and tree goodly (T. Yerushalmi, Succah 3:5). Another rabbi claimed that *hadar* (which is Hebrew for "goodly") is derived from *hadir* meaning "dwelling," referring to the presence upon the tree in all seasons of the fruit in some stage of its growth (T. Bavli, Succah, p. 35). Rabbinic discussion continued throughout the subsequent centuries. Maimonides held that the identification of citron with the "fruit of a goodly tree" was based upon an absolutely trustworthy tradition. Commentators such as Leon da Modena, who were less firmly convinced of the citron's authenticity, saw in the problem an affirmation of the necessity of tradition. He pointed out that the very fact that it was impossible to know what fruit was originally meant emphasized the importance of tradition as a guide to Jewish law (*20*).

Arguments against Early Presence of Citron in Palestine

Recently a historian of citrus has revived the entire question by stating his belief that the citron could not have been growing in Palestine even as late as the return from Babylonia, by which time the celebration of the holiday was, beyond question, established. Another fruit, according to this view, must have originally been used. S. Tolkowsky, assuming an Indian origin for the citron tree, asserts that the tree had not reached Mesopotamia as late as the end of the fourth century B.C. and did not reach Palestine until the second century B.C. He rejects the evidence of the seeds found at Nippur, arguing that these remains constitute evidence of a tribute of rare fruits brought from a foreign country (*21,* p. 43). But the core of Tolkowsky's theory depends upon Theophrastus of Eresos, who wrote during Alexander's campaign in Asia in the fourth century B.C., in his *Inquiry into Plants,* what has become a classic description of the citron. Theophrastus wrote that the citron is called the "Persian or Median apple," and Tolkowsky deduces from this that the citron was not yet growing in Mesopotamia (*21,* pp. 48–51).

According to Tolkowsky, the ancient and authentic "fruit of a goodly tree" was the cedar cone. He claims that the word *hadar* in the phrase *"pri etz hadar,"* instead of being a single word meaning "goodly," is compounded of the Hebrew definite article *ha* and *dar,* the name of a specific tree—the dar tree, *Cedrus deodara,* a holy cedar of India. The change from the cedar cone to the citron resulted, Tolkowsky believes, from the cone's widespread use in pagan cults. According to Tolkowsky, it was Simon the Maccabee who, in order to emphasize the difference between Jew and pagan, replaced the pine cone with the citron, similar to it in appearance, and struck a coin in honor of his reform, supposedly effected in 136 B.C. The citron is depicted on this coin, together with the "lulav," or combination of palm branch, willows, and myrtle prescribed for use on the Feast of Booths (*21,* pp. 52–57).

One objection to Tolkowsky's ingenious theory is that nowhere else in the Old Testament, which abounds in botanical references, is the dar tree mentioned. Moreover, internal evidence from the text of Leviticus argues against his thesis. The fruit of a goodly tree is only one of a number of items which the Jew is instructed in this sentence to take, and it is unlikely from a stylistic point of view that the definite article should precede only one of the objects whose use is commanded (*22*). Equally without foundation is Tolkowsky's theory of the way in which the citron came to be substituted for the pine cone. The coin upon which the citron's introduction was supposedly celebrated was struck, not in 136 B.C., but, as recent scholarship has disclosed, in the first century A.D. (*23*). Figure 4 shows a similar coin. There is ample documentary evidence from this period that the citron had been in use for a considerable length of time.

As for the evidence of Theophrastus cited by Tolkowsky, this may be interpreted rather differently. At the time Theophrastus wrote, the Persian kingdom embraced the entire Fertile Crescent; hence, the phrase "Persian or Median apple" is ambiguous. Nor does the fact that this name was given to the citron in the particular region where the observer upon whose description Theo-

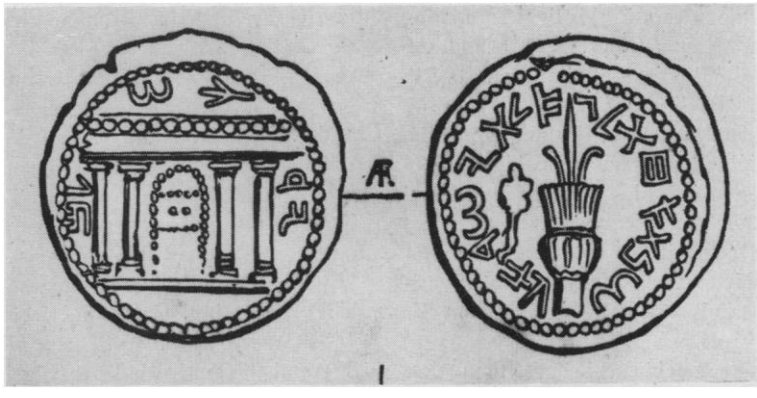

Fig. 4. A Judean tetradrachm of the second revolt (A.D. 132–135), showing lulav and etrog and the inscription, "Jerusalem First Year of the Redemption of Israel. [Frank J. Darmstaedter, Jewish Museum, New York]

phrastus relied encountered it exclude the possibility that the citron was found in other areas where it might have been known by other names. It should be remembered, too, that Theophrastus did not write of plant discoveries but of plants which had long been familiar to the Greek world (*24*). This suggests that the citron was probably cultivated in areas further west than Media or Persia.

But even if we set aside the flimsy and sometimes actually incorrect specific evidence offered by Tolkowsky, we find that his approach to plant distribution is essentially naive. He implies that, in order for the citron to reach Palestine, it must have traveled in an orderly sequence through successively adjoining regions. Thus the citron could not have been in Mesopotamia before its acclimatization in Persia, and acclimatization in Mesopotamia was necessary before the fruit could be introduced into Palestine. Such a view of plant spread is peculiarly inaccurate in the case of cultivated plants, such as the citron, which are dependent upon human beings for their distribution. Palestine is the meeting place of Irano-Turanian, Saharo-Sindian, and Mediterranean vegetation belts. Furthermore, in the Palestinian part of these belts there are many local enclaves characterized by plant associations ranging from tropical to Alpine, within only 40 miles of each other. Thus the chances for the tree's finding a suitable habitat in Palestine are in no way dependent on its prior introduction to Mesopotamia.

Spread of Citron in the Mediterranean Diaspora

But whatever may have been the fruit originally designated by "fruit of a goodly tree" (and there is no reason why the citron should not have been meant), by the first century A.D. the fruit was firmly established. In the reign of Alexander Yanai, who also officiated as high priest, we know of the citron's widespread acceptance through its use in an unexpected manner. When Yanai, in performing the temple service for the Feast of Booths, deviated from the ritual accepted by the mass of the people, the worshippers hurled their etrogim at him (T. Bavli, Succah 4:9; Josephus *Antiquities,* XIII, xiii, 5). So universal was the citron at this period that the Jews considered adopting it as a standard of measure. Rabbi Akiva, a noted scholar of the first century A.D., arguing against such use of the citron, produced one so large that he was forced to carry it upon his shoulder (*25*). In the Talmud, a scale of sizes is established in which the citron ranks at the head and the mustard seed at the foot (T. Yerushalmi, Nazir 1:4).

Fig. 5. A stone from an ancient synagogue in Priene, Asia Minor, showing candelabra flanked on the left by the citron, on the right by the lulav. [Kaiser Friedrich Museum, Berlin]

While it is beyond dispute that the citron was accepted as the "fruit of a goodly tree" at the turn of the Christian era, what is the evidence that the Jews took the citron with them into the Mediterranean as they formed the early communities of the Diaspora? The reason why they might have done so is clear: The citron had assumed great importance to the rabbis and the common man alike. Rigid specifications were laid down by the rabbis to which all citron used for the holiday ritual had to conform: the fruit must be fresh; its skin must be undamaged; the stigma and style which are carried on its protuberant nipple must be in place; and at least the base of the stalk must be attached to the fruit (*26*).

For the citron was more than an object used in ritual performance; it was a fruit with rich symbolical associations. The evidence for this is found primarily in the stories of the aggadists, who are the source of much of the legend and folklore concerning the Bible. According to one aggadist, the etrog corresponds to the heart of man (*27*). The citron tree, goes another aggadic legend, was the tree of knowledge of good and evil (*28*). Of course Western civilization is familiar with the apple, but this legend, too, grew from aggadic sources, and throughout the Middle Ages the two legends interlocked so that apple and citron were frequently substituted for one another in common usage (*29*).

Not only to the rabbis and aggadists did the citron assume symbolical importance; the common man participated in these attitudes. While no specifically religious symbols appeared in Jewish art until about 40 B.C. (*30,* vol. 1, p. 273), from this time on the citron was one of the most common motifs on Jewish inscriptions, tombs, mosaics, and ritual objects (Fig. 5). Indeed, to a foremost student of Jewish art, the presence of the citron on unquestionably Christian remains is sufficient to indicate the presence of Jews or Judaizing influences (*30,* vol. 2, p. 97).

The accompanying map (Fig. 6) shows the universality of the etrog symbol in the Jewish Diaspora of the early Christian centuries, as well as the extent of Jewish settlement both in towns and on the land. The existence of the symbol on Jewish remains in a given area does not in itself constitute proof that the tree was grown there. Nor does the absence, to date, of the symbol in areas where we know Jewish communities to have existed mean that further archeological investigation would not disclose the citron in these places as well. The probability is great that wherever Jewish communities existed in the Mediterranean world there was common usage of the citron symbol, and that wherever it was at all practicable the Jews not only drew, but also grew, the fruit.

The map further shows, by what is at least an interesting coincidence, that the centers of early Jewish population (with the exception of Israel, these centers are no longer Jewish) roughly coincide with the centers of present-day Mediterranean citrus production—that is, Mediterranean Spain, Algeria, Sicily, Calabria, the Nile delta, and the Levant coast of Israel, Lebanon, and Syria. Morocco and Tunisia are not today primary centers of citrus production, but it is worth noting that one of Morocco's two producing centers for citrus, the Sebu basin (especially the area between present-day Meknes and Fez), coincides with the region of Volubilis, an early Jewish pale. Significantly, moreover, Morocco and Tunisia remain important producers of citron, and up to very recent times the Tunisian citron even supplied sections of the Palestinian market. Morocco continues today to be a source of supply for the American market (*31*). It is my belief that it is the antiquity of citrus culture, originally introduced in these regions by the Jews, for whom cultivation of other citrus species was a by-product of citron cultivation, which explains the persistence of this horticultural specialty. It is interesting, in this light, that citron trees in these areas, certainly from the tenth century on, repeatedly served as grafting stock for other varieties of citrus, particularly the orange (*21*, pp. 105–107; 32).

As Jewish communities multiplied in the Mediterranean Diaspora, references to the citron among non-Jews increased and became more accurate. In the period of Theophrastus the citron was considered inedible by the Greeks (*33*), and as late as about A.D. 70 Pliny recorded the same opinion of the citron (*Historiae Naturalis,* XII, vii, 1). That Jews, on the other hand, ate citron we know from the practice of the period of the Second Temple, when children ate citron on the last day of the Feast of Booths (T. Bavli, Succah 4:7). Coincident with the increased dispersal of Jewish communities came the recognition, by the Romans, that the citron was edible. Indeed, citron recipes became common, and the fruit was frequently prescribed for its supposed medicinal or magical virtues (*34*).

While there is no clear documentary evidence to show that the Jew introduced citron into the Mediterranean, the first records of the cultivation of citron from Jewish and from non-Jewish sources are from those areas with the oldest and largest Jewish communities. Thus, citron is found in the Peloponnesus, one of the earliest centers for Jews outside Palestine, probably at the end of the first century A.D., and there is definite proof of its cultivation there in the second century A.D. (*21,* pp. 75, 77). We know that in Mauritania, another area of early Jewish settlement, the citron was intensively cultivated at the beginning of the Christian era (*21*, p. 69). Clearly, if the citron was grown at all in Italy at this time it was still a rarity. The only really reliable evidence pointing to the presence of citron trees in Italy, where for a long time after their acclimatization they were known as "Palestinian trees," comes from Pliny, who mentioned the citron as one of those trees "which have already become naturalized with us" (*Historiae*

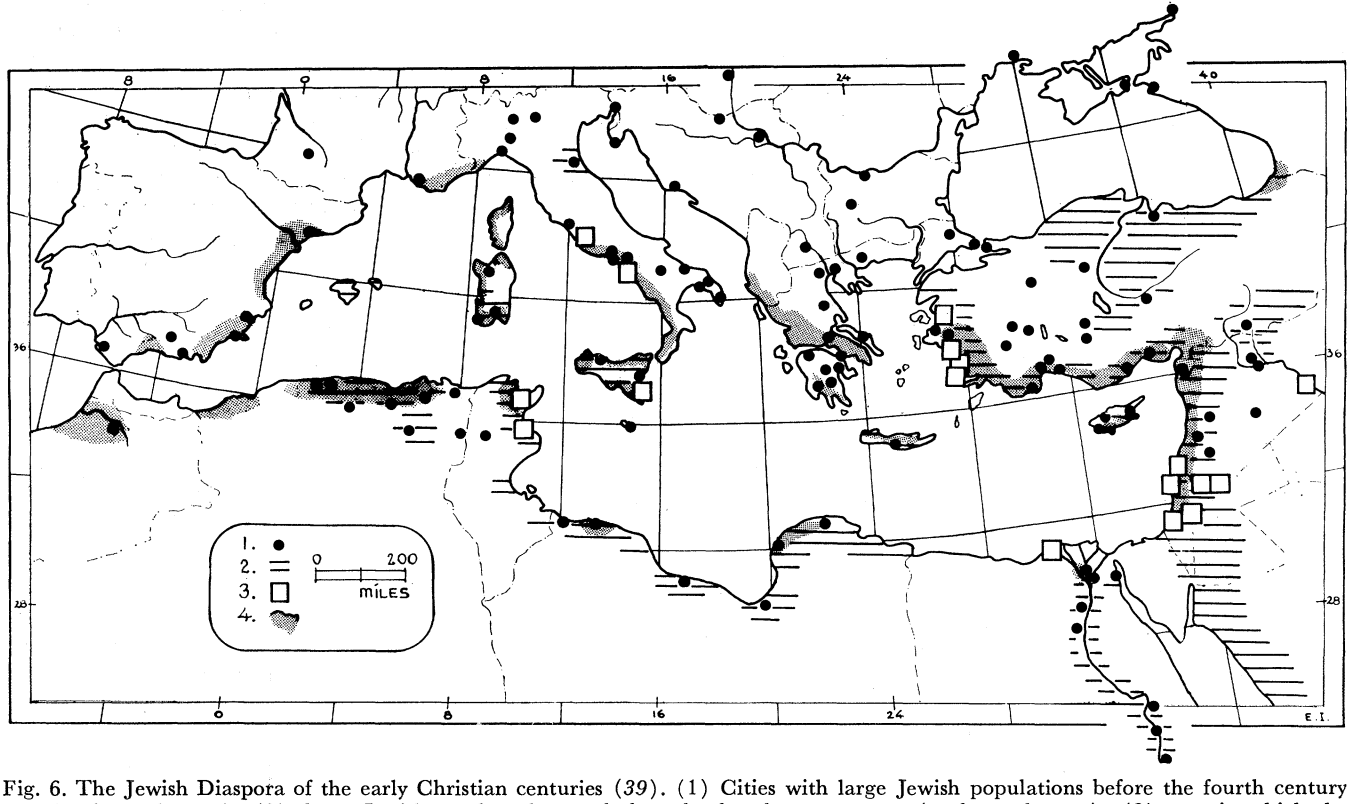

Fig. 6. The Jewish Diaspora of the early Christian centuries (*39*). (1) Cities with large Jewish populations before the fourth century A.D. (so far as known); (2) dense Jewish rural settlement before the fourth century A.D. (so far as known); (3) area in which the etrog has been found depicted in situ; (4) areas of contemporary commercial citrus production.

Naturalis XII, vii, 1). The citron appears in Roman art around the middle of the first century A.D., when it is found as a relief in the tomb of the Haterii on the Via Labicana. It occurs on wall paintings in Pompeii showing Jewish or Judaizing influences (*30*, vol. 2, p. 55). But although the citron was present in Italy, it was by no means a common fruit, for at the beginning of the fourth century its cost was still relatively high. In Diocletian's edict of A.D. 301, fixing prices, the maximum price for a citron was set at 24 denarii, whereas a melon was set at 2 denarii (*35*).

Role of Jews in Introduction of Other Citrus Fruits

It is highly reasonable to assume that the Jews, to whom the citron was such a vital part of religious observance, were the prime agents in spreading the fruit and, as a by-product, in making it acceptable to the non-Jewish population. Only the most perfect fruit might be used as etrogim, and for the less perfect citron it was also desirable to find a market. It is, moreover, highly probable that the Jews introduced other citrus fruits along with the citron and at least contributed to their spread. It is commonly assumed that the orange and lemon were introduced into Europe in the tenth century by the Arabs and that before this time the fruits had been unknown there. But it is scarcely likely that in a period when citron was intensively cultivated, the orange and lemon, fruits which have similar requirements, should have been overlooked by the Jews. Indeed, the Talmud mentions the "sweet citron" (T. Bavli, Shabbath, p. 109b) and the "spherical citron" (T. Bavli, Succah, p. 35a), both of which are now taken to refer to the orange. Different fruits of the genus *Citrus* tended for a long time to be given a common name, and the particular fruit was distinguished by the adjective applied to it. As late as the tenth century the Persian physician Abu-Mansur Muwaffaq stated that oranges were commonly called "sweet lemons" (*21*, p. 106). S. Tolkowsky was the first to point out that sufficient evidence exists in Hellenistic and Roman art and literature for us to conclude that the orange and lemon were known in the early Christian centuries (*21*, pp. 100–109). What appears most probable is that cultivation of citrus other than the citron died out in the centuries following the fall of the Roman Empire and that the fruits were reintroduced by the Arabs.

The Jews became outstanding horticulturists in the Mediterranean in the first centuries of the Christian era, and it may well be that the Jew's need to grow citron was a factor in leading him to pursue this vocation. In Tarragona and Granada Jews owned the vineyards and orchards surrounding the towns (*36*). Jewish ownership of groves in the Balearic Islands at the end of the fourth century is likewise established (*37*). The extent to which Jews were cultivators of land can be shown in Sicily, a center of early citron production, where, by the beginning of the seventh century, Jews worked as *coloni* in large numbers on the lands of the church. In Lombardy the extent of actual Jewish landownership attracted the adverse criticism of Pope Gregory I, who wrote to the Bishop of Luna in Tuscany that he thought it wrong that the Jewish farmers should use Christian slaves on their land. He suggested that the Jews only be permitted to employ Christians as serfs (*38*).

In spite of increasing restrictions imposed on Jewish landownership in Christian Europe from the fifth century on, as late as the twelfth century Jewish horticultural skill was famous. When King Roger of Sicily wished to commence sericulture in Corfu, he imported a community of Jewish horticulturists into that island. It is highly probable that this marked the beginning of the growing of citron on Corfu, which was subsequently to become a primary source of etrogim for the Jews throughout northern Europe.

The spread of citron and the attendant horticultural arts from Palestine to other Mediterranean shores is an instance of the influence of religion upon the development of the cultural landscape. The difficulty of separating out religiomagical motivations from economic, political, and other forces has led to the minimization of the former. The geography of religion is, as a result, the least developed of all geographic specializations. In fact, it has largely become a cartographic exercise in mapping the distribution of obviously religious categories—for example, distributions of population according to religion; distributions of churches, mosques, and other types of religious architecture, and so on. While there is no gainsaying the usefulness of such mapping, it stops short of examining the influence of religion on regional economic structures. Failure properly to take into account religious forces in the modification of the landscape frequently leads to insufficient explanations of historical processes. The early history of citrus in the Mediterranean cannot be explained in terms of economic or social needs but depended upon the religious beliefs and observances of a people, based, in turn, upon rabbinic interpretation of a Biblical commandment. If we accept the view that oranges and lemons were introduced with the citron at an early period, the disappearance of all types of citrus except the citron can similarly be explained only in terms of religious motivation. In the anarchy following the fall of the Roman Empire there was no group to whom the cultivation of oranges or lemons was of vital interest; the citron alone continued to be grown without interruption, and frequently in the face of great difficulties, because it fulfilled the religious obligations of one segment of the Mediterranean population.

References and Notes

1. *Citrus medica* is, indeed, of such minor importance in world trade that the Foreign Agricultural Service of the U.S. Department of Agriculture does not compile data on the world trade in citron.
2. The citron is also known as *Citrus medica cetra, C. medica* var. *lageriformis* Roem., *C. limon scabiosa, C. media* var. *cucurbitina* Risso & Poit. and *C. medica* var. *cylindrica* Hort.
3. See H. J. Webber in *The Citrus Industry*, H. J. Webber and L. D. Batchelor, Eds. (Univ. of California Press, Berkeley and Los Angeles, ed. 1, 1943), vol. 1.
4. J. H. Burke, "The Citrus Industry of North Africa," *U.S. Dept. Agr. Foreign Agr. Rept. No. 66* (1952), p. 113.
5. A. de Candolle, *L'Origine des plantes cultivées* (Paris, ed. 5, 1912), p. 142; W. Roxburgh, *Flora Indica* (Serampore, India, 1832), vol. 3, p. 392; J. D. Hooker, *Flora of British India* (Reeve, London, 1875), vol. 1, pp. 484–517; D. Brandis, *Indian Trees* (London, 1906), p. 122; E. Goetze, *Ein Beitrag zur Kenntniss der Orangengewächse* (Hamburg, 1874), p. 16. After the turn of the century the same view was presented, notably by Sir George Watt in *The Commercial Products of India* [(London, 1908), p. 325].
6. E. Bonavia, *The Cultivated Oranges . . . of India and Ceylon* (Allen, London, 1888–1890), p. 70.
7. I am indebted to E. Milne-Redhead, T. A. Russell, and George Taylor of the Royal Botanical Gardens, Kew, England, and to H. L. Li of the Morris Arboretum, Philadelphia, Pa., for their clarification of current thought on the question of the native home of *Citrus medica*.
8. See W. T. Swingle in *The Citrus Industry*, H. J. Webber and L. D. Batchelor, Eds. (Univ. of California Press, Berkeley and Los Angeles, ed. 1, 1943), p. 397. It is almost certain that there were floral and faunal transfers, attendant on ancient human migrations, between the monsoonal realm of southwest Asia, southern Arabia, and eastern Africa, although the directions and sequences of such dispersals and migrations cannot be established with certainty. Six-rowed barley, developed from *Hordeum agriocrithon*, was probably introduced from India through southern Arabia into Ethiopia. By 4000 B.C. this had become the staple of the Egyptian Badari [see H. von Wissmann, *Erdkunde* 11, 91 (1957)]. Southern Arabia also plays a prominent role in the dispersal of millet and the distribution of Zebu cattle [see E. Werth, *Botan. Jahrbücher* 73, 106 (1943)]; see also the comparison of southern Arabian palms with those of Africa and southwest Asia in M. Burrett, *Botan. Jahrbücher*, 73, 175 (1943).
9. R. Heinegeldern, *Diogenes* No. 13, 82 (1956).

10. F. Petrie, *The Making of Egypt* (Sheldon, London, 1939), pp. 65, 71.
11. W. F. Albright, "The Biblical period," in *The Jews, Their History, Culture and Religion,* L. Finkelstein, Ed. (Jewish Publication Society of America, Philadelphia, 1949), vol. 1.
12. W. F. Albright, *Archaeology and the Religion of Israel* (Johns Hopkins Press, Baltimore, 1940), p. 134.
13. J. O. Thomson, *History of Ancient Geography* (Cambridge Univ. Press, 1948).
14. E. Bonavia, *The Flora of the Assyrian Monuments and Its Outcomes* (London, 1894), p. 68.
15. F. von Frimmel, *Sitzber. Kais. Akad. Wiss. Wien. Phil.-hist. Kl.* 173, 181 (1914); S. Killermann, *Naturw. Wochschr.* 16, No. 31, 201 (1916).
16. S. el-Din Ahmed, *Egypt. Ministry Agr. Tech. Sci. Serv. Bull. No. 109* (1931), p. 61.
17. W. Bretschneider, *On the Study and Value of Chinese Botanical Works with Notes on the History of Plants and Geographical Botany from Chinese Sources* (Foochow, 1870), p. 12.
18. W. F. Albright, *From the Stone Age to Christianity* (John Hopkins Press, Baltimore, 1940), pp. 228–230. For Indian affinities of the faith of ancient Israel, see B. Hrozny, *Ancient History of Western Asia, India and Crete* (Artia, Prague), pp. 162 ff., especially pp. 178–183.
19. Plutarch, *Symposiaca Problemata* IV, 5.
20. L. da Modena, quoted by I. Löw, *Die Flora der Juden* (Vienna and Leipzig, 1924–1926), vol. 3, p. 287.
21. S. Tolkowsky, *Hesperides: A History of the Culture and Use of Citrus Fruits* (Bale, London, 1938).
22. I am indebted to Prof. Ezekiel Kutscher of the Hebrew University, Jerusalem, for the stylistic analysis of the text.
23. L. Kadman, *Israel Exploration J.* 7, 62 (1957).
24. Pauly-Wissowa, in *Real Encyclopädie der Classischen Altertumswissenschaft* (Stuttgart, 1940), vol. 7, suppl., pp. 1435–1465.
25. The etrog referred to in T. Bavli, Succah, p. 36b, may have been very large indeed. J. H. Burke ["The Citron Industry of North Africa," *U.S. Dept. Agr. Foreign Agr. Rept. No. 66* (1952), p. 39] states that some of the citrons produced in North Africa weigh as much as eight pounds each. In 1673 a certain Padre Gonsales wrote: "In Calabria I saw very fine citrons weighing several pounds apiece, but those at Tripoli, in Syria, are still bigger, as big as ordinary melons, so that I dare not state their weight since it would sound incredible" (*Reyse vanden eerw.* Pater P. A. Gonsales, *Minder-Broeder Recollect.* (Antwerp, 1673), vol. 2, pp. 372–373.
26. See "Etrog," in *Encyclopaedia Talmudit,* M. Bar Ilan and J. Sevin, Eds. (Jerusalem, 1949), vol. 2, p. 129.
27. N. E. Rabinowitz, Ed., *Midrash Hagadol Levayikra* (New York, 1932), p. 587.
28. J. T. Berlin, Ed., *Breshith Rabbah* (Berlin, 1912), p. 140.
29. I. Löw, *Die Flora der Juden* (Vienna and Leipzig, 1924–1926), vol. III, p. 229.
30. E. R. Goodenough, *Jewish Symbols in the Greco-Roman Period* (Pantheon, New York, 1953).
31. G. F. Callaghan, Plant Quarantine Division, U.S. Department of Agriculture, personal communication, 23 Jan. 1958.
32. W. T. Swingle, "Citron," in *Standard Cyclopaedia of Horticulture,* L. H. Bailey, Ed. (Macmillan, New York, 1914), vol. 2, p. 779.
33. Theophrastus, *Enquiry into Plants and Minor Works on Odours and Weather Signs,* A. Hart, trans. (Loeb Classical Library, London, 1916), IV, iv, 2.
34. See, for example, Athenaeus, *The Deipnosophists or the Banquet of the Learned,* C. D. Younge, trans. (London, 1854), vol. 3, pp. 141–142.
35. Pauly-Wissowa, in *Real Encyclopaedie der Classischen Altertumswissenschaft* (Stuttgart, 1899), vol. 3, pp. 2612–2621.
36. H. Grätz, *Geschichte der Juden* (Berlin, ed. 3, 1895), vol. 5, p. 54; J. J. van Nostrand, "Roman Spain," in *An Economic Survey of Ancient Rome,* T. Frank, Ed. (Johns Hopkins Press, Baltimore, 1937), vol. 3, p. 219.
37. G. Caro, *Die Juden in ihrer Wirtschaftlichen Betatigung im Mittelalter* (Frankfurt, 1904), p. 423.
38. I. Schipper, *Anfänge des Kapitalismus bei den Abendländischen Juden im frühen Mittelalter* (Vienna and Leipzig, 1907), p. 13.
39. The main sources used in the mapping of the Diaspora were J. Oehler, *Monatschr. Geschichte u Wiss. Judentums* 30, 292–302, 443–452, 525–538 (1909); J. Juster, *Les Juifs dans l'empire romain* (Paris, 1914); J. B. Frey, *Corpus Inscriptionum Iudaicarum* (Rome, 1936). The distribution of the citron in archeological evidence is mainly based on material presented by E. R. Goodenough in *Jewish Symbols in the Greco-Roman Period* (Pantheon, New York, 1953–1954), vols. 1–4.

CURRENT PROBLEMS IN RESEARCH

Reappraisal of the Soil

Pedogenesis consists of transactions in matter and energy between the soil and its surroundings.

C. C. Nikiforoff

What is soil? Soil technologists and agronomists define soil as the medium which provides the foothold and the mineral nutrients for land vegetation. Agronomy inherited this old concept of soil from the tillers of land, for whom the soil is just the "dirt" supporting their crops. This simple utilitarian concept of soil is so deeply entrenched in people's minds that one may wonder whether it would not be less confusing to leave the term *soil* entirely to agronomy and coin some other name for the geochemical surface formation which is referred to in agronomy as "the soil."

Without agronomic bias, the soil or its geochemical equivalent might be defined as an excited skin of the subaerial part of the earth's crust. In order to clarify this definition it is necessary to define *earth's crust* and to say a few words about the nature of the excitation of its integument.

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Earth's Crust

The term *earth's crust* is intended to designate the 10-mile-thick outermost layer of the silicate geochemical shell. This shell, the probable thickness of which is in the neighborhood of 100 kilometers, consists of igneous rocks and their derivatives. Igneous rocks are largely made up of oxygen, silicon, and a half-dozen other elements, including aluminum, iron, calcium, potassium, sodium, and magnesium. These eight elements make up more than 98 percent of the mass of igneous rocks. Less than 2 percent of the shell is made up of other elements, the contents of which range from several tenths of one percent (for titanium) to mere traces.

Oxygen makes up only a little less than half of the whole mass of the shell, but, because its density is low, it constitutes by volume more than 90 percent of the bulk. Silicon is the next most abundant element in the earth's crust. It makes up about 27 percent, by weight, of igneous rocks (*1*). The density of silicon, however, is much higher than that of oxygen; hence, in igneous rocks silicon constitutes less than 1 percent of the volume. Aluminum and iron are the only other elements each of which makes up more than 5 percent of the mass of the earth's crust (*1*).

On the average, there are about 63 atoms of oxygen in every 100 atoms making up the earth's crust. All the oxygen is combined with other elements to form various oxides, which are arranged into crystalline lattices of rock-forming minerals, such as quartz, feldspars, and pyroxenes.

Crystals of silicates, which make up more than 90 percent of the mass of igneous rocks (*1*), are essentially oriented clusters of large oxygen ions, thoroughly interbraced by the much smaller ions of silicon and aluminum and holding ions of other elements in the interstices of the