

DEPARTMENT OF AGRICULTURE.

CULTURE OF THE DATE.



BY W. G. KLEE,

Gardener in Charge of Agricultural Grounds, University of California.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1883.



[Report no. 24]

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success, at least in this region, while their example of planting in upper California gave the impulse to planting in more suitable localities in this latitude.

In Lower California, especially at Mullise and Loreto, the date-palm is cultivated regularly, and the product is sold in Guynas, on the opposite side of the Gulf. Of the source of these plantations we have no certain information, but from what I have learned of Mr. Carlos Gompertz (late of the University of California), for a long time a resident of Guynas, and who has traveled extensively through Mexico, it appears that all the oldest date plantations in Sonora are at the missions, or in their immediate vicinity, and there is therefore every reason to believe that here also they were introduced by the mission fathers. From his statement as well as others, it appears that dates are cultivated regularly in Southern Sonora, and when attended carefully and receiving plenty of water they ripen delicious fruit, which in places are eaten as real food. The fact that the date thrives in Sonora, in a climate where heavy summer rains prevail, would at first seem to indicate that the fruiting of the date-palm is not confined to as distinct and peculiar a climate as the investigations of its culture in the Old World would lead us to believe. Closer examination, however, shows that the conditions here are very similar to those of Punjab, the northwest province of India, where summer rains do not seem to be detrimental to the date, because occurring chiefly during July and August, while the time of blooming and that of fruit-ripening, early spring and fall, are dry. This, probably, is also the case in Florida at the points where date culture is said to have proved successful. It is an established fact that date culture is a success in Southern Sonora and Lower California, and we know that the climate of Upper California possesses the most important condition for date-growing, viz., that of a long rainless season, which seems to compensate for the less amount of actual solar heat, the former condition being so important that its fulfillment enables the date to ripen as far north as 38° northern latitude, a circumstance I shall refer to later. The date-palms found at the old missions in Upper California are unfortunately very few, and have for many years grown without proper care.

At the mission church in San Diego large trees, perhaps more than a hundred years old, are still living; and while they produce fruit every year this never seems to mature. The location where they grow is very dry, and as no attention whatever is paid to the fertilization of the flower, it is not strange that the fruit should not ripen. Beside these, there exist several other date-palms scattered through the town of San Diego, none of which, according to the information I have been able to obtain, ever matured fruit.

Farther up the coast, in Los Angeles County, especially in the beautiful valley of San Gabriel, date-palms may be seen here and there; but here also there is no record of ripened fruit. The same is the case at

Santa Barbara, at W. W. Hollister's farm, where a number of date-palms are growing, characterized by a stunted, bush-like appearance. Unlike these in aspect are some beautiful trees near the mission church of San Buena Ventura, their tall, palm-like growth being striking to every one. Whether this difference in appearance is due to variety or to climate, or to both, it is difficult to say, though the similarity of the latter points to the difference in variety as being the cause. As to the production of fruit we have not been able to obtain any reliable information.

DATE-GROWING IN CENTRAL CALIFORNIA.

At the Rixford farm, near Sonoma, Sonoma County, an interesting case of a young male palm flowering at the age of six years from the seed was reported by Mr. J. P. Rixford some two years ago. The male spike from this tree exhibited at the meeting of the California State Horticultural Society had apparently well-developed pollen, characterized by the penetrating but agreeable odor belonging to the date flower. As there was no female tree blooming there at the time, fruit in this case was out of the question.

That, on the whole, fruit could have matured properly, even under favorable circumstances, in any of the localities mentioned is rather doubtful. San Diego, although far enough south, has a very moderate average summer temperature, owing to its proximity to the sea. The same objection applies to the more northerly points at Santa Barbara and Buena Ventura, as even the portions of Africa to the seaward of the Atlas is unsuited for date culture. And while the more protected valley of San Gabriel has a fine, uniform climate, very suitable for the orange, it has not the requisite amount of summer heat for ripening any but very early varieties, which of course would only be raised by accident from the dates of commerce, the source whence all these trees seem to have sprung. At the place in Sonoma mentioned above, the season must be considered altogether too short for maturing dates, unless it should be the New Algerian variety referred to in the California Horticulturist for the year 1877.

When it is taken into consideration that in most of the cases mentioned no particular care has been given to the date trees, and that in all cases they have been grown from seeds (a mode of propagation only practiced in very favorable localities, for the reason that the same variety does not perpetuate itself in this way any more than our apples and pears), it is not surprising that only negative results have been obtained. It is the more interesting to note some results of date-growing in the northeastern part of Sacramento Valley, the Putah Creek and Vacaville region. It deserves mention that, although as far north as 38°, this part of California furnishes the earliest fruit in the San Francisco market, even earlier than counties much farther south.

As this region seems to present the most interesting cases of date-growing, and no doubt the only instance of dates coming to full maturity in Upper California, I have taken pains to investigate personally the place of experiment and to receive information from the first source on the spot.

About the year 1857 or 1859 some fresh date seeds were procured in the San Francisco market and planted on Mr. J. R. Wolfskill's original place, near Winters, Yolo County, on Putah Creek. The young seedlings sprouted easily and received but ordinary care, and were planted permanently the next year in a place about 100 yards from the creek-bed. The site is high above the creek-bed (about 25 feet), and in the fall of the year (October, when we examined it), far from being moist, although the character of the soil, an extremely rich, fine, sandy loam, is such as will allow seepage. The trees received the same care as the rest of the orchard wherein they were planted—careful cultivation, but no irrigation.

Some years ago this place passed into the hands of Mr. S. C. Wolfskill, a brother of Mr. J. R. Wolfskill, who removed to a place farther down the creek. Subsequently he removed a number of date-palms to this his present home, but being quite large most of them died, and at present only one, a large male tree, is alive. The remaining plants (a number of which afterward were cut down, so that their number was reduced to six) continued to grow finely, and are to-day large trees, averaging 25 feet in height, some more and some less, and with trunks 2 feet or more in diameter. As they stand close together—about 6 feet apart in a row—their size is remarkable.

Only two of these trees have ever shown flowers, both being females, bearing for the first time at about the age of fourteen years; and of these one has continued to do so every year, being now loaded with fruit, having five large "règimes,"* or clusters, averaging 20 pounds weight in the unripe state. Although there is no male tree here, the nearest place where any are grown being Mr. J. R. Wolfskill's, about a mile and a half away, these dates obtain good size (about one inch and a half in length), but do not ripen fully, while the seed is but imperfectly formed. Of course if it receives fertilization at all it is by chance, carried by insects, as the male tree stands to the leeward of the female.

The coming year the tree will be properly fertilized, and it will then be determined whether the non-producing is owing to its being a late variety or to the want of fertilization, or to both. The two trees at Mr. J. R. Wolfskill's stand near his house in a more favorable locality, though the male tree spoken of before is shaded and its trunk bent somewhat, owing to the proximity of a large olive. The female tree, which is of comparatively low stature, stands some 15 feet from the male, and has a full exposure to the sun.

* Name given to the date-bunch in the date countries.

This tree, the only one that ripens fruit, is evidently of a totally different variety from the male, and is the only one remaining from a lot of trees raised by Mr. Wolfskill, the seed of which was bought, under the name of African dates, in 1862. It is therefore twenty years old now. It is 5 to 6 feet in circumference, and 6 feet up to the first fresh leaf, where also the r \acute{e} gimes are attached. It bore fruit for the first time when fifteen years old, but owing to the picking of the fruit, Mr. Wolfskill never obtained enough to judge of its quality. It did not produce fruit again until 1881, when for the first time there was obtained fruit in abundance, probably 100 pounds or more, in five r \acute{e} gimes, some of which were exhibited at the San Francisco Bulletin office.

The fruit is of a very beautiful red-wine color, contrasting very effectively with the bright yellow stems, about an inch and a quarter long, perfectly smooth; different in this respect from that of the non-maturing variety on Mr. S. C. Wolfskill's place, which is sharply triangular. The maturing date-tree blooms in April or May, while the staminate tree is much earlier, sometimes two months before, and is passed out of bloom when the pistilate is ready for fertilization. How the fertilization is accomplished, therefore, is a matter of doubt and not a little singular, the only plausible explanation being the prolonged vitality of the pollen. That fertilization is accomplished cannot be questioned, as the fruit produces many fine fertile seeds, from a few of which plants have been grown. That the pollen is capable of retaining its vitality for many years is a well-known fact, but in that case, of course, it must be protected from the influence of the open air and sun.

Another interesting case of date-growing is that of Mr. G. W. Fraser, of Elmira, Solano County. Mr. Fraser obtained seeds of some fresh dates just received by Mr. W. R. Strong, of Sacramento. From these he raised the date-palms now growing on his place, all of which are female trees. At the age of ten years they produced fruit, which, however, never ripened, as of course was to be expected, owing to the want of fertilization. The soil wheret these trees are growing is also a rich, sandy, alluvial loam. Like Mr. Wolfskill's dates, they received no special care and have never been irrigated.

Besides the cases mentioned there is at least one more instance of date-growing in this section; but it has been impossible to learn the particulars, owing to the remoteness of the locality. The data in hand give us, however, some very important points.

CONCLUSIONS.

In the first place, they establish the fact that the date-palm will grow in latitude 38° north to a large size in a comparatively short time; that it will fruit in shorter time than in latitudes several degrees farther south in the eastern hemisphere.

Fifteen years is the average age of bearing in North Africa when raised from the seed, while, as we have seen, there are instances here of bearing at as early an age as ten years. Mature fruit has

been produced without artificial fertilization, the neglect of which everywhere causes failure of the crop, at least in northern latitudes of the date zone. When we remember that date-palms generally are grown from the offshoot, or sucker, as the only means of regulating the variety, the proportion of sexes, and that only by artificial fertilization a crop can be depended upon, we must consider the above fact very encouraging. These remarkable results can only be explained by the fact that the Californian climate possesses two factors of the greatest importance for successful date culture, a rainless, hot summer, and a dry, clear atmosphere. It cannot be denied that these circumstances promise well for a culture which is the more important because it can be carried on in a climate, in a soil, and with a water supply that no other useful plant will endure. For, as will appear from the following treatise, *the date-palm grows and flourishes in places where the grapes would be burned on the vines; in a soil too poor and too purely mineral for any other fruit tree; and it produces the finest and best flavored dates, nourished by water too alkaline for man and beast to drink.*

The great probability of successful date culture over a large part of this western coast in Southern and Central California, as well as parts of Arizona and Colorado, wherever water of some kind may be procured, will become apparent to every one who takes the pains to read the appended abstract from Professor Fisher's carefully compiled work.

One cannot help being struck by the great similarity of climatic conditions of the date zone to those of the regions named, and the possible great usefulness to immense tracts now lying waste. It is well known that in the so-called arid regions of this State, as well as in those of Arizona, a great many of the springs and rivers are charged with alkalis, which render them unfit for any culture except that of a few plants originally growing in saline regions, such as beets, asparagus, &c. In California the Tulare Lake basin is of this character, rendering successful culture in many cases very uncertain. If in the date-palm we have a tree adapted to all of these regions, or only part of them, then the importance of this culture cannot easily be overestimated.

In the following pages a review of what we have considered the most important of Professor Fisher's work is given. It treats of the history and details of date culture, as well as of the climatic influences governing its distribution; and upon that basis I have made a comparison with the conditions of the eastern hemisphere to that of certain regions on the Pacific coast, supplemented with the statistical record of temperatures, together with the analyses of the waters of the same:

ABSTRACT OF PROF. THEOBALD FISHER'S MONOGRAPH OF THE DATE PALM.

[Petermann's Geogr. Mittheilungen, Ergänzungsheft No. 64.]

The original home of the date-palm, like that of the cereals and other plants cultivated from time immemorial, is difficult to point out with certainty.

Some, and with them the celebrated African traveler, Schweinfurth, believe that the wild palm species, *Phoenix spinosa*, is the parent form; but this, as Professor Fisher argues, is rather improbable, this species being at home in a completely tropical climate, with summer rains and their consequences, altogether outside the region in which the date-palm comes to maturity. All probabilities point to its being a native of the desert region, and the Fezzans claim the neighborhood of Traghden as its home.

Wild date-palms are found scattered in Arabia and on the Sinai peninsula in smaller or larger groves. The ancient grove on Mount Sinai is termed Baal's grove, and the name of Baal's dates is, indeed, given to these wild palms throughout Arabia. The date-palm was found wild by Palgrave at Ghat in the heart of Arabia, at an elevation of 3,000 feet.

It appears that only three countries can be brought in question as its home, namely, Egypt, Arabia, and Mesopotamia. In Egypt its existence can be proved at an exceedingly early date, perhaps earlier than any other form of vegetation. It is often pictured on the temples; and the tall columns and capitals are, indeed, striking images of the trunk and leaves of the date-palm. At the festival of Isis the leaves were always used, and the regular development of about twelve leaves during the year served as a symbol of the twelve months with the ancient Egyptians.

Date seeds or stones have been discovered in Chaldean graves, the age of which must be attributed to the second if not to the third thousand of years before Christ. The importance of the date-palm is dwelt upon by Strabo; how it in Babylon satisfies nearly all wants. "Bread, wine, vinegar, honey, flour, and all kinds of basket-work, the stone burned by the blacksmith as coal, and, softened in water, used for food for cattle and sheep." As to Arabia, owing to the want of early records, we know actually but very little before the time of Mohammed. But the sacredness in which the tree was held and the honor given to it in the Koran, which commands that it should be honored like a relative, speak strongly for its antiquity. It follows the faithful even beyond the grave, in Paradise, where, under the shade of the palms, by the murmuring brooks, they shall meet and love the beautiful dark-eyed maidens never touched by man nor genii.

On the whole, the date-palm plays in Arabia quite another part than in many other countries, where it is more of a luxury; it is here, in a much higher degree than in any other country, the food-plant. It is the chief nourishment of the poor. This is most strikingly seen when a failure of the date crop by a ravage of locusts occurs, as famine is much more frequent from this cause than from the failure of the grain crop. Date shops take in Arabia the place of the baker's shops of other countries, and here the date is sold fresh, or as the pressed date-bread seen in commerce, while separate shops are frequently found where only the stones are sold, the softer kinds for cattle and the harder for fuel. The trade with dates in the interior also replaces the grain trade, and we find speculations and "corners" made in dates, just as in the case of wheat with us.

The date-palm is closely linked to the existence of the Arabs from olden times, and, indeed, large tracts of land would without this tree be here uninhabitable. We may even safely say that had it not been for the date-palm Arabia would not have played its part in history, nor brought forth the conquering hosts, the apostles of Islam. From linguistic reasons, also, we are led to believe that the date-palm is of great antiquity in Arabia; both the name of the tree, *nacht*, and that of the fruit, *tamr*, must be reckoned among the oldest part of the Arabian language, as both are among the simplest words, the latter especially, being a root. From these three countries, probably, the date spread to the neighboring land of Canaan, where it was more an ornamental tree, but, as in Egypt, used on all religious occasions.

From the Phœnicians the Greeks learned to know the date, and it received for this reason its name *Phoenix*. From here it spread to the Ionian Islands, where it was already growing at the time of Homer.

With the conquering Arabic nations the date-palm spread all over Southern Europe, and its culture was carried on successfully in many parts of Spain during the reign of the Moors. Great and carefully compiled works describing its culture were written at this time, but, unfortunately, nearly all of these have been lost.

PROPAGATION.

The propagation of the date is done in two ways: from seed, or from the "suckers" or sprouts that spring from the root. The growing from seed is the least practiced, for the reason that neither can the same variety be thus maintained, nor can the right proportion between staminate and pistillate trees be established. It necessitates also the cultivation of a great number of superfluous staminate trees for many years.

Seedlings are generally two to three times as long in coming into bearing as suckers, and they are usually characterized by a large stone and little flesh.

In North Africa a seedling will have a well-developed crown in three or four years, but does not come into bearing in less than twelve to fifteen years, while five to six years suffice for fruiting from the sucker. In the Beled el Dscherid, the date country of Northwestern Africa, especially that adjoining Tunis, both ways are practiced; on Saharan oases, in Fezzan and Mesopotamia chiefly that of raising the offsets.

These suckers are in Fezzan called *maghrusa*, and are planted in the fall without any special preparation of the soil, but are kept watered for a couple of months, every two or three days, when they will be rooted sufficiently to grow readily in a porous soil. The distance apart in planting varies greatly. In Algeria there are planted one hundred trees per hectare, either regularly in rows, or, as it seems, in scattered groups, governed by the water supply. In the rich Egyptian delta they are planted very close, as little as 5 feet apart in quincunx, and to every twenty pistillate trees one staminate. In the South Persian terrace lands they are also planted in quincunx, but at about six steps' distance, and the same proportion of staminate to pistillate trees as in Egypt. In about five years the trees commence to bear fruit, and in the eighth year they are taxed. They do not, however, give a very abundant yield before they are ten or fifteen years old, and a full crop is looked for at the age of thirty. At eighty to ninety years they commence to give less, but nevertheless a tree may become as old as two hundred years. In Southern Kirman the Persian border commission was shown trees, still in full vigor, said to be one hundred and fifty years old.

A very curious way of renewing an old tree, practiced with exceptionally good varieties in many different localities, is already spoken of by Theophrastus. It consists in surrounding the lower part of the stem with about 6 feet (2 meters) of mud, which is constantly kept moist. In this roots will strike out within a year. The stem is then cut through below this and planted afresh, when it will again flourish for a number of years.

The date will reach a height of 50 to 80 feet, but its growth is very slow. Owing to the long time needed for trees to come to maturity, but more, perhaps, to the care necessary on an oasis, where a continued warfare with the encroaching sand must be kept up, the destruction of the date-palms is considered a very wicked act. It is nevertheless very often practiced between warring tribes, though the common and quickest way of taking vengeance is to hew down the staminate trees alone. The trunk of the date-palm is so elastic that, though heavy winds may bend the crown to the ground or even tear the tree out, root and all, it is never broken. It has a diameter of from 30 to 60 centimeters (1 centimeter is equal to about one-half inch), and is usually swollen at the root; but sometimes also in the reverse manner, thin below and thicker above. One or more narrow places on the trunk, which are caused no doubt by a temporarily too limited supply of water, are often seen. It is a remarkable fact that the growth of the date-palm is the same whether the tree stands in the middle or on the outskirts of a grove, exposed to wind and weather. The crown is formed of from forty to sixty leaves, and every year the lower ones die off and are replaced above by

new ones. Generally once a year, in the month before flowering more often than in those after, the dead ones are carefully removed, and the stumps of the sheath give the tree a stunted appearance, which only gradually disappears.

The remnants of the leaf-sheaths are of considerable importance, as they greatly facilitate the climbing of the tree. The flowering and the fruiting of the date occur of course at different times, according to the variety and the latitude and altitude. On the northern limits of palm culture the flowering occurs in April, as in Egypt, the Algerian Sahara, on the coast of Tripoli, and even on the oasis of Tebes (North Persia).

Farther south the palms bloom earlier, in March or even in February, as in some localities in the Libyan Desert, which have even a milder climate than oases located farther south, where the middle of March is the time of flowering. The middle of March is also the time of blooming at Schat el Arab and in Central Arabia. At the southern limit the flowering probably takes place throughout during February. Besides, it is possible to hasten the blooming of the date by very plentiful irrigation. The artificial fertilization, which is commonly practiced, is usually done in the following way: The staminate flower raceme is opened as soon as the anthers by touch give a kind of cracking sound, which indicates that the pollen is sufficiently developed.

The flower raceme is picked to pieces and a piece put into the open pistillate raceme, so that fertilization and fecundation must be accomplished. The pollen will keep a long time and will stand being sent long distances without losing its efficacy. Hence it is customary in the palm district of Southern Persia to keep a package of pollen for cases of emergency, when the staminate (male) palms might be destroyed, an occurrence not very rare among those warlike tribes. On such occasions it has been proved by actual experience that the pollen has not lost its fertilizing power after a period of eighteen years.

The climbing of the trees for the purpose of fertilizing is quite a difficult task, but, besides irrigation, nearly all that the inhabitants of the oases have to do. To leave the fertilization to insects or to the wind is risky and generally causes failure. As stated before, in Egypt there is planted about one staminate to twenty pistillate; one to a hundred only is, however, strictly necessary. In Mesopotamia the date variety with dark fruit is only slightly fertilized, while the light-colored ones receive more. It is believed there that if the dark ones receive too much pollen the dates drop before ripening.

RIPENING OF THE FRUIT.

Between ripening and flowering there is a lapse of time which is shorter and shorter the nearer we come to the south limit of date culture. The dates do not ripen at one time, but during several months, though the chief crop comes at once. The close attention given to the different stages of ripening is best proved by the fact that in various countries the fruit receives different names according to its stage of development. The time of ripening varies exceedingly, and though the different degree of earliness may make a vast difference, the fact mentioned by the traveler Rohlfs, that in Sinah (an oasis in the Sahara) he ate ripe, fresh dates from the tree in the month of February (the ordinary time of blooming), is difficult to explain, except on the supposition that these palms have a second distinct crop. The main crop, even in warm countries, does not come in before August, while in more northerly and cooler localities the date harvest does not occur before September and October.

HARVESTING.

The dates of the finer sorts are harvested by picking singly, in baskets; the common kinds, however, by shaking the bunches, or by cutting off the bunches altogether. This can, of course, only be done at the main harvest. Most varieties are

taken off before completely ripe, and afterward ripened in the sun; but in many places the people like to eat them in the unripe state. The total yield of the date crop is, with careful culture of the tree, subject to but few variations, although different in different years and countries. Only invasions of locusts and similar occurrences will cause complete failure.

The yield of individual trees depends chiefly on its age and water supply. In Algeria a tree has generally about eight bunches, each on an average of about 8 kilograms (the kilogram is a little over 2 pounds), but weighing as high as 20 kilograms a bunch.

The value of the product is estimated at about 3 francs per year for each tree; in Egypt 25 piasters 34 para, 6 francs, say, \$1.15. The production varies, however, very much in different localities; in Mudureh, Assint, 65.48 piasters; in Gharbieh only 10 piasters 10 para. The value of the total yield in the whole of Egypt is estimated at 115,838,763 piasters. For every tree there is paid here $1\frac{1}{2}$ piasters as a tax, which, however, is often increased considerably by extra taxes. The weight of a bunch is from 15 to 20 to as much as 50 rattles (a rattle is 0.56 kilograms, about 10 ounces), and such a tree will bear from six to twelve. Every bunch may bear as high as 2,000 dates, so that on an average a tree bears about 18,000 dates. In Algeria the tax is 1 franc; on the poorer kinds 30 to 50 centimes.

In Fezzan, according to Nachtigal, the well-known traveler, some trees give a camel-load of dates, about 200 kilograms, though generally half a dozen trees are needed to make up this. In the very elevated oasis of Bafk (about 4,000 feet, in Kirman, Persia), on the northern limit, trees give, according to J. Abbot, about 130 English pounds of dates, while farther south, according to another traveler, a tree in a good year will bring from 250 to 400 pounds. In the southern terrace-land of Persia the yield from the best trees is as high as 170 kilograms. Farther west, in Dalaki, between Buchir and Schiras, each tree is estimated to yield 50 kilograms. In the northern palm oasis of Iran, in Tebes, according to the botanist Bunge, a full-grown tree gives yearly 200 marx ($3\frac{1}{2}$ pounds). In Oman (Southeast Arabia) the value of a palm-tree is estimated at \$7 to \$8, and its yearly production worth \$1.50. We see, therefore, that the yield is very variable—as variable as our fruit crop, according to adaptation of soil and climate.

VARIETIES.

Like our own fruit-trees, cultivated for thousands of years, there have been developed a great many varieties of the date, the number of which increases sensibly from the outer limits toward the inner and central part of the date zone. Where the conditions are the most favorable the culture is older and more careful. While, for instance, in the palm oasis at Elcke, in Spain, and in Tebes in Persia, only two varieties are distinguished; in Arabia and in the Sahara the number swells to more than a hundred. It must, however, not be understood that the difference in variety is as easily recognized in the form and general habits of the tree as with our apple-trees, where a trained eye recognizes the kind when seeing it in full leaf.

With the date-palm it takes a trained eye even to know a pistillate from a staminate tree; but that this was possible was already known to Pliny. Only a few kinds may be known by their growth, as for instance the amber-colored, transparent Khalas date from Laprá, which is easily recognized by its slender stem, less bushy foliage, and smooth bark. In the neighborhood of Bagdad also there are varieties that can be recognized by the foliage; but only the pistillate palms can be so distinguished, while of the staminate trees hardly any can be recognized.

Martins distinguishes scientifically seven varieties; *Phanix silvestris*, with small cylindrical or olive-shaped fruit, which is, however, always dry, without flesh, and bitter; *P. cylindro carpa*, with larger, long, cylindrical, acute, sweet, and fleshy fruit; *P. sphæro carpa*, with egg-shaped, pointed fruit; *P. gonio carpa*, with angular fruit;

P. sphærosperma, with papery or leathery flesh and roundish, soft stones. The people distinguish, besides these, a great many different varieties, chiefly by the consistency of the fruit, but also by the shape, taste, thickness, color, and time of ripening. According to the consistency of the fruit they are divided into hard and soft; of which the former are the more prized on account of their better keeping qualities. The soft dates, which are the best-tasted, can only be kept in dishes or bladders, in which they are pressed and as much as possible kept air-tight to prevent moulding and fermentation. These date varieties, therefore, can be studied only in the oasis itself. According to Marmol, who knew most of the oases in North Africa, the dates at Wadi Draa (Southwest Morocco), for instance, are so delicate that they are destroyed by the least moisture, like sugar. They are, therefore, hardly ever exported; but those that are must be most carefully packed in baskets. The shape of the date stone determines the shape of the fruit, and the oasis-dwellers will tell with certainty from the stone the quality of the fruit. Seedless dates, which are among the best kinds were found by Desfontaines in Beled el Dscherid, by Bunge in the Tebes oasis, and a long, seedless variety of very good quality was purchased cheaply by Palgrave on the table-land of Nedschd (in the heart of Arabia). They are, no doubt, cultivated in other places also.

The nomenclature of the various varieties is very uncertain, and cannot be depended on even within the same oasis. In the Tunisian Beled el Dscherid the cultivated varieties have been estimated at from fifteen to sixty, according to various writers. The number in the Libyan désert is given at one hundred, and Cosson gives the names of seventy-five different varieties from the Ziban oasis. Of these we shall name some to give an idea of the extraordinary accuracy with which the oasis people distinguish the qualities according to taste, color, &c., and how it occupies their minds and imaginations. It gives an insight into the spiritual life of the Orientals, and of the desert inhabitants in particular, and shows more than anything else the value of the date-palm:

Deglet Nur.....	The Light date.
El Ghars.....	The Sucker.
Amekentechi Deglet	The Early Ripening.
El Arschetz.....	The Long and Narrow.
El Itima.....	The Orphan.
El Hamraja.....	The Red.
El Kendi.....	The Sugar.
El Halna.....	The Sweet.
El Ghazi.....	The Warlike.
El Dekmasi.....	The Silky.
Bent el faki.....	The Daughter of the Lawyer.
Haluat el Ulach.....	The Sweetness of Ulach.
Hamret bechri.....	The Forerunner of Sweetness.
Deglet debah.....	The Hyena date.
El Aschaja.....	The Evening date.
Heurt el Arab.....	The Noble of the Arabs.
Sebâa el Arus.....	The Bridegroom's Finger.
Bar el Djahesch.....	The Colt's Dung.
Khen Schusch el dil.....	The Reserve Treasure of the Jackal.
Deglet el Hamar.....	The Donkey date.
El deglet el beidha.....	The White date.
Temzezet.....	The Sour-sweet.
Chetui.....	The Wintery.
Schedret.....	The Pearl on the Row.
Bahdja.....	The Shining.
Djerboa.....	The Jumping Rat.

Kern el Ghézel	The Horn of the Gazelle.
Sessok lohwi-Itihia	Strike it, and it falls.
Deglet bu Sekhraja	The Camel-driver date.
El Khebelia	The Confused.

Of seventy-five named, the value of which is different, thirty-five are distinguished as soft, and forty as hard. Of the latter the Light date is the most searched for, while the Camel-Driver date is chiefly used as provision on desert journeys. In Tunis the most prized date is the Monakhir or the Nose date, which becomes as long as the small finger. Other excellent Tunisian sorts are Deghlas, the Royal date from Beled el Dscherid, and the Island Dscherba (by the Tunisian coast), which are especially shipped to Germany, and particularly to Berlin.

The dates of Tafilet (Morocco) have the name of being excellent; they are chiefly eaten in Morocco, especially a green variety, which is named Buni. It has a small stone and is very sugary and sweet. In Rhadames (oasis in the Sahara, west of Tripoli) the most common date is Medhanen, which is very small, black, and olive-shaped, resembling a variety common in Persia. In Fezzan (country south of Tripoli) the varieties of dates become very numerous, and as many as three hundred are mentioned by some; but they do not compare with those of the Tunisian Beled el Dscherid or Dongola (Upper Egypt). The highest prized ones at Murzuk (Fezzan) are Tillis, Tuati, and Auregh. In Sinah (Northern Egypt), according to Rohlf, the finest sorts are the Sultani and the Rhaselli. There are many others, but an especially good one is a small white date, a camel-load of which brought \$8 in Sinah and from \$15 to \$20 in Alexandria. The varieties most prized in Cairo are Balah Amiri, a large, red date, which is chiefly exported to Europe, dried; and Balah im hot, a small yellow date, which is excellent for sweetness. It comes chiefly from the plantation at Gizeh Htar-ennebi and Deir el tin. The large Amiri dates come chiefly from the province of Scharikijeh.

In Nubia the dates from Ibrim are famous; still more the sweet aromatic Sultano from Sukkot and Say, which become three inches long. In Arabia they distinguish a great many varieties; at Medina not less than one hundred and thirteen. The most famous of these are Agua and Burdi, and Seihani from Cheibar (east of Medina). A much sought, but rare, variety was once the Djelely, produced from only one hundred palm-trees at Medina. It became 3 inches long and 1 inch broad, with an agreeable odor.

A very small sort is the Heleya, not larger than a mulberry. The Birny is one of the most wholesome and easy to digest; it was the favorite food of Mohammed, and he advised every Arab to eat seven Birny in the morning. One kind of Medina dates remains green even when ripe and dried; another keeps its beautiful saffron color, and is, therefore, drawn on threads, under the name of Kalayd el Scham, and used like coral beads for necklaces.

The elevated taif (south of Mecca) produces a sort which becomes as long as a finger. In Nedschd, where the dates are extremely sweet, a red and a long stoneless variety are most prized. In Basra (in Mesopotamia), so famous for its dates, they distinguish, according to Niebahr, between cold and hot dates, of which the former are considered healthy, but the latter injurious; the former are dear, the latter cheap and the food of poor people.

The Chastani is held to be the best, because it does not trouble the digestion, no matter how many are eaten, while the Zahidi overloads the stomach, and is, therefore, chiefly used for cattle feed and for brandy distillation.

A great number of date varieties are found in Basra; Niebahr counted twenty-eight. The Basra dates are considered better than those of Bagdad, of which, also, there exists quite a number. Michaux relates that in the Delta of Schatt el Arab, from Bender Righ to Mina, the most delicious dates are cultivated, called royal dates, Tschurma Shahi, and used as presents for kings and princes, being brought to Ispahan and Schiras. Southern Persia has a number of date varieties, among which some

are found resembling olives. A black variety cultivated in Bafk (Kirman) probably comes from the terrace-lands of Iran.

USES OF THE DATE.

Dates are eaten fresh as well as dried; and it is customary to eat in the fresh state those varieties which do not endure the sun, becoming soft under its influence. These are allowed to become quite ripe, while those to be stored are not allowed to ripen fully; but there are localities where the unripe dates are eaten by preference. The superior kinds are pressed in a more or less soft condition in dressed and tanned goat-skins, which are sewed up carefully and kept in this way. Mats are also used for this purpose. This gives the so-called date cake, or Akuch, from which, by dissolving in water, a wholesome and cooling drink can be prepared. In South Morocco these pressed dates serve, alone or mixed with flour, for a soup much used by caravans. From the dried dates a kind of flour may also be prepared, and a dough from this. In short, they allow a great many modes of preparation.

In Sinah the dried dates are stored in magazines with only a wall around and open above, and here all palm owners bring their dates for storage, although it is accessible to birds. Subterranean and hidden stores are also found in the small oases in the desert near the palm plantations, and these are seldom altogether exhausted. Stored in this manner dates are said to keep for seven years. In the drying of the dates some honey flows out. This is procured also in Beled el Dscherid by placing dates of the soft varieties in earthen jars provided with holes and subjecting them to slight pressure. By regular pressing the date sirup, or so-called dips, is obtained; it is very much prized and is used with bread. The best is made from the particular sweet date, known as the Hellan from Basra, and others from Nedsch (high table-land in the heart of Arabia). From the poorer sorts and the wind-falls a kind of brandy is made, which, however, generally does not agree with Europeans.

Dates are the chief nourishment of many of the natives in Northern Africa, Arabia, at least among the poor. Such is the case in Oman, where dried meat and dates is the standing dish; while the Bedouins and mountaineers live almost exclusively on dates and milk. Now, as in ancient times, dates and fish are the subsistence of the people along the coast of Eastern Beloochistan. According to the testimony of Fresnel there are Bedouin tribes whose sole nourishment is dates for six months of the year, while for the other half year it is milk, honey, and the like. In the markets of Arabia, especially in Hedschas, date stores take the place of baker shops, and the dates, cut out and sold by the pound, are the commonest food of all classes of people. Dates are eaten in many different ways; they are, like potatoes, with which they may best be compared in importance, the principal food of the poor.

In Arabia there is a saying that a good housewife ought to know how to prepare a dish of dates different for every day in the month. Usually they are eaten with butter or with oil, as in Mesopotamia and South Persia, or they are boiled to mash with milk, fried with butter, or cooked to thick gruel and eaten with honey. A too exclusive diet of dates is held to be injurious in many places; the chronic gastric troubles so often occurring in the interior of Arabia are ascribed to this. It is also, as might well be supposed, injurious to the teeth. A kind of wine is made by simply pouring water over the dates and leaving them overnight; the morning finds ready this quickly made drink, of which the Arabs are very fond.

Of much more importance, however, is the so-called Lagbi, the real palm wine, which is derived from the sap of the tree and has been known from olden times. This product is obtained in various ways. The crown of the tree is hewn off and a hollow is made in the stump, into which the sap flows for one to two months in rapidly decreasing quantity. This rough process of course kills the tree. More profitable is the manner practiced in the oasis of Gabes (Tunis), and which seems to be adopted in all the oases in Sahara. Here the leaves of the crown are taken off without hurting the heart of the tree, the wounds being renewed every day. In this manner a tree

may give daily for three to four months eight to ten liters of palm sap or milk. Then the wound is allowed to heal over, and the next year the tree may bear fruit again. After a lapse of two years the process may be repeated, and there are trees that will stand this operation three times. Another manner is by running a little pipe of bamboo into the sap-wood and receiving the sap into dishes. The time of flowering is the best for procuring palm wine, as this is the time of the greatest sap-flow. Not every palm-tree, however, is fitted for the production of palm milk. It depends on and varies according to age and variety. This palm milk the Mohammedans are permitted to drink, and the Prophet himself was a great lover of this whitish blue, almost disgustingly sweet, drink. As this, however, rapidly ferments and becomes palm wine, there is produced in the course of two days a very strongly alcoholic drink, especially when the process is hastened by using uncleaned dishes, permanently used for this purpose. After several days vinegar is formed from the wine. As it is very difficult to determine when the palm milk has passed into wine, the faithful may without danger allow themselves the full use of this intoxicating drink.

According to Nachtigal, the African traveler, the Lagbi has at the beginning of the fermentation process an agreeable sourish-sweet taste, but the consequences are not very salutary, as the fermentation continues in the stomach. Nevertheless, the desert people used to this beverage consumed great quantities of it. In Nubia a kind of brandy is prepared by boiling the dates and leaving them to ferment for ten to twelve days. This does not appear to become vinegar as rapidly as the milk, but can be kept a year, or even more. The heart-leaves of the dates are eatable, tasting like chestnuts, and are known as palm cabbage. As this, of course, cannot be gotten without destroying a tree, generally old blown-down trees only are taken for this purpose.

INFLUENCE OF THE DATE-PALM ON THE CULTURE OF OTHER PLANTS.

The importance possessed by the date-palm has been dwelt on already; it is the greater because it is satisfied with such a soil and irrigation as no other food-plant would endure; but its importance is not confined to its own direct products. It indirectly promotes and protects the cultivation of other useful plants. In the shade of the date palm it becomes possible to raise many different trees and cereals otherwise impossible to cultivate alone on account of the intense heat of the sun reflected from the burning sand. The fruit trees cultivated here are, without exception of the countries of the Mediterranean, apricots, peaches, figs, almonds, grapes, mulberries, and pomegranates, now and then olives, plums, and apples. These obtain from the crown of the palm just enough shelter against the vertical rays of the sun. Besides, wheat is cultivated in its shade, and its southerly limit corresponds with that of date culture. In fact, nearly all kinds of cereals, vegetables, and culture plants, such as cotton, are cultivated in the shade of the date-palm, and, as before said, their cultivation would hardly be possible without its protection. In Beloochistan the people even have a special name for a date-palm grove where other cultures are carried on; it is called Kelug. Only in the poorest oasis, where the soil is bad or irrigation impossible, no additional low culture is found.

TRAFFIC IN DATES.

The export from Tunis to Germany alone was 1,275,300 pounds, worth 381,347 marks; while the export from Egypt was, in the year 1877, 2,956,700 piasters.

The greater part of the dates produced in Arabia remain there; the dates from the date-oases going to the non-producing parts, where coffee, &c., are received in exchange. Still, large quantities are exported to Northern Africa and India; and in the latter place they are used a great deal for the making of arrak.

SOIL AND IRRIGATION.

There are few plants of which the production is restricted to such marked and special conditions as the date-palm. When grown as a fruit tree this has become better understood, now that the climatic peculiarities of the desert have become better known. As regards the condition of soil most favorable, it has already been testified from olden times that it thrives best in a light sandy soil. The freer from humus and the poorer for other plants the soil is, the better thrives, if not the tree, at least the fruit. In the fat, richly watered soil of the Nile oasis the tree thrives finely and makes a beautiful growth, but its fruit does not compare favorably with that of the more poorly growing trees of the Libyan Desert. Still, the Nile alluvium, which, according to Schweinfurth, consists of firm clay, colored dark-brown by humus, and rich in mixture of sand and mica, must be regarded as a favorable soil, as, in fact, is proved in Nubia, where in the pure desert climate excellent fruit is gotten. Very similar is the alluvial soil of Lower Mesopotamia—a firm, blue, or fine gray sandy loam, here and there replaced by sand, but strongly charged with salt. It is on this that the fine Basra dates are produced. An investigation by Professor Knop of the Nile alluvial soil near Thebes, a good date region, gave 1.17 per cent. humus and 85.50 per cent. fine earth. In 100 parts of the fine earth were contained 57 parts of silicic acid, 35.20 iron oxide, and 2.22 lime, magnesia, potash, and soda. The Nile alluvium is characterized by a very high percentage of iron oxide and poverty in organic substances, in which respect, as well as in its high absorptive power, it resembles the soil of the oasis. In the Algerian Sahara there are localities where the soil consists of 80 per cent. silicic acid, 13 per cent. of sulphate of lime, and 7 per cent. of carbonate of lime, and where still the palms thrive. The soil of the oasis consists of a light sandy marl; that of Djofra of sand mixed with particles of lime. In the Zibau oasis, according to Nachtigal, it is sand mixed with clay, in which even in this latitude good dates are grown. In the Persian oasis Khabis the soil, according to Bunge, is clayey, sometimes even firm clay, and mixed with sand, and salty. On a clayey, salty soil grows the palm grove of Katscha, in Belcochistan. The name (El Khasim), the famous date country in Nedschd (Arabia), signifies a sandy but fertile soil, and, according to Palgrave, consists of a yellow or red sand, which proves very fertile wherever it is irrigated. It therefore appears that a certain quantity of sand and salt in the soil is preferred, and that even in the delta of the Nile the latter (salt) is present in spite of the yearly inundation would be inferred from the presence of salt-marsh plants, such as *Traukenia*, *Atriplex*, and others, growing as far as Thebes, unless, indeed, they are to be considered as stray plants from the desert, which do not propagate themselves there. At any rate, all Arabian writers that have written about the date-palm and its culture agree in the point that to flourish the date requires a salty soil.

Ibn el Tassel, from Andalusia, who wrote in the eleventh century, prescribes how much salt there ought to be mixed in the manure prepared for the soil in which the dates are to be planted. Singular is the case testified to by Erenberg and Hemprich, from the island Farsan, in the Red Sea. Here travelers found date gardens where the palms grew directly from the fissures in the coral rocks, of which the island consists, and they were irrigated from wells. If we, therefore, cannot consider it proved that the date-palm (absolutely) requires a salty soil, or that it takes up and assimilates these salts, they are no doubt beneficial for it at least.

From these investigations we must conclude that the soil adapted for the date-palm is a light, porous soil, always more or less sandy and calcareous. Soil of the latest formation, whether formed by sediment or by disintegration, is the soil for the date, for nowhere is it found on a soil of older formation.

IRRIGATION.

Much more important, however, than the character of the soil is irrigation. The large amount of water required by the date is mentioned by all writers from the oldest

time to this. If this cannot be supplied by natural conditions, by the tree having its roots all the year round in a moist soil, then irrigation must be resorted to.

In many localities these conditions are fulfilled, as in several certain parts of Arabia and in the Nile delta. The most extensive date culture without irrigation exists probably in Fezzan, where the roots of the date-palm almost everywhere reach the water-table, and at most, shallow draw-wells are used; likewise the oasis archipelago Nilzana, in the Tunisian Beled el Dscherid, which is said to count one hundred villages. The abundance of springs, which in some places burst through as torrents, and in others fill large natural basins, is so great that hardly any irrigation is necessary, and in spring the ground is covered with swamps. Not much different is the Arabian date district, El Casim. Here Palgrave found the water-table within six feet of the surface, or even less, in the driest time of the year, the month of September, while during the winter all the wells are full to overflowing, forming small lakes; and, as it seems, irrigation is used only for cereals and vegetables. A very peculiar kind of irrigation is that practiced in the Algerian oasis archipelago, Wed Suf. Here the water-table is at considerable depth, and to make the roots reach it the trees are planted in funnel shaped pits twenty-five feet deep, which are dug out in the loose sand. The dam-like edges are protected by palisades of palm leaves against the blowing of the sand. Gypsum blocks are also utilized in this way. Such pits or holes are called ritans. At the bottom of these the palms are planted irregularly, and manured carefully with camel's dung gathered from everywhere. The labor in digging out these ritans is very great, but not less than that of keeping them in order, owing to the drifting sands.

The palm-tree assumes a remarkable form in these hollows. Its stem becomes a short thick cylinder only a few meters high with an enormously developed crown, with branches five meters long; thus resembling the low massive pillars of the Egyptian temples. When by a sinking of the water the roots are too far to reach it, and the tree begins to suffer, it is tied to a neighboring trunk, the roots dug out, and the sand taken away from under the roots. The tree is then again lowered until it comes near enough to the water. The appearance of these ritans is peculiar from a distance, as only the crown of the tree is seen, and only when the ritan is reached is the intention of this laying out understood. The yield of trees by such care is astonishing; enormous régimes (bunches) hang in the tree and the dates reach perfection in these funnels; protected from the wind and exposed to the reflection of the sun and increased heat of the sand-walls, they become fleshy, oily, and very sugary. Under the shade of the palm, by means of artificial watering from small draw-wells, vegetable gardening is carried on and the suf man here raises his cabbages, turnips, carrots, millet, and perhaps a few figs, apricots, and pomegranates. These fruits are his all. Dates take the place of money, for with dates the workman is paid, and for dates all necessaries of civilization are brought from Tunis.

In a few other localities in Egypt and Mesopotamia, by the Indus, and at some points by Wadi Draa (Southern Morocco), no artificial irrigation is practiced. In general it must, however, be said, inasmuch as the date zone is in the driest region of the earth, that irrigation, and partly very artificial irrigation, is necessary for palm culture. It is, however, carried on extensively in a most primitive style in most of these countries. As the date-palm flourishes in a salty soil it might be expected that wells or springs very salty or strongly charged with other substances would be utilized for irrigation. One of the bored artesian wells contains three grams of sulphate of potassium in one liter, one to two grams of sulphate of lime, besides chloride of potassium and carbonate of lime. Its temperature varies between 23° C., 73°·4, and 25° C., 77°·8. Irrigation with this brackish water is not only not injurious, but on the contrary seems to be beneficial.

In the Algerian Sahara the best dates grow in the oasis watered with brackish water, as also in other places near Katif (in Lahsa, east coast of Arabia); in the whole of Fezzan, where only very few wells are completely sweet; and in Bakarar, in Rhat

(both oases in the heart of the Sahara). In the Persian oases of Bafk and Khur, even the flowing Biskra (Algiers), which contributes to water the oasis of the same name, contains considerable quantities of common salt and sulphate of magnesia (Epsom salt).

According to the analysis of Buvry it contains water and organic compounds..... 997.764

Common salt.....	0.878
Sulphate of magnesia.....	0.474
Sulphate of soda.....	0.280
Sulphate of lime.....	0.448
Carbonate of lime.....	0.156
	1,000.000

It is to be presumed that very many, if not the majority, of the waters coming from the Atlas chain will show a like strong admixture of salts. The dates watered with the muddy sweet waters of the Nile are far inferior in quality to those of the oasis irrigated with the brackish water. A comparison in this respect with some of the waters of the Pacific coast will be interesting. It has been mentioned above that a number of bored wells in Algeria used for irrigation of the date-palm contained as much as from one to three grains of sulphate of potassium per liter, which is equal to about sixty to one hundred and eighty grains per gallon, and one to two grains per liter of sulphate of lime, equal to about sixty to one hundred and twenty grains per gallon, or a total residue of one hundred and twenty to three hundred grains per gallon of these salts. According to the analysis made at the University of California, under the direction of Prof. E. W. Hilgard, of the waters of Tulare and Kern lakes, during the year 1880, they contained—

Grains per gallon of—	Total residue.	Carbonate of soda.	Common Glauber's salts, &c.	Carbonate lime, magnesia, and silica.	Vegetable matter.
Kern Lake.....	211.50	64.37	115.41	9.29	22.43
Tulare Lake, south end.....	84.44	27.92	37.85	13.44	2.28
Tulare Lake, middle, surface.....	81.95	35.30	35.96	5.37	5.32
Tulare Lake, middle, 10 feet below surface.....	81.83	30.46	39.49	7.47	4.41
Tulare Lake, middle, 20 feet below surface.....	81.72				
Tulare Lake, near mouth of King's River.....	38.55	13.46	15.01		4.97

We see that the residue is in no case as large as that of the wells of Algeria, but, it will be observed, of a much more dangerous character, the carbonate of soda being especially so. How strongly charged the soil might become with the sea salts without injuring the date-palm could only be determined by actual experiments; but in this case we have a very practical remedy, that of gypsum, which, owing to the very nature of circumstances, single trees a considerable distance apart, could be applied with very little additional cost. The gypsum, if spread around each palm-tree right at the root crown, would neutralize the

carbonate by converting it into a sulphate, which we know agrees perfectly with the date-palm, even in large quantities. The practicability of neutralizing carbonate of soda has been illustrated on a large scale in Los Angeles County, where it was done at the suggestion of Professor Hilgard, and found perfectly satisfactory.

As regards the neutral salts, especially sulphate of potassium, found naturally in a number of localities in the State of California, the very fact that we have no remedy against them, save that of leaching them out, points to the date-palm as the fruit tree to plant wherever their presence in too large quantities excludes other culture plants.

The numerous borings of artesian wells by the French have increased the productiveness of the oases wonderfully, for the yield of the date-palm seems to be in direct ratio to its water supply. According to the engineer Jus a well is capable of supplying water to three times as many palms as it gives liters per minute; for instance, a well giving 60 liters per minute supplies 180 palm-trees, or 0.30 for every palm. Trees that received at the rate of 0.30 to 0.33 liters per minute were finely developed, and bore more than those which received less. But trees receiving from 40 to 50 per day were still better developed, and bore 20 per cent. more fruit.

Those that stand near the well bring yearly 20 régimes. With an irrigation of from 0.40, to 0.50 liters, the dates give the fullest yield and allow besides the culture of cereals beneath the trees. The quality of the water, however, seems not to be as important as the quantity.

The palms are watered the whole year round, most abundantly in spring before flowering, and in summer before the ripening of the fruit. It has been observed that those irrigated most bloom earlier and more abundantly.

The quantity of water necessary for a palm-tree during the hot season is estimated in Biskra at 100 cubic meters. Although the water for irrigation is generally brought in open canals, a system of underground irrigation-ditches is found in a number of places. It seems to have been practiced the longest time on the highlands of Iran, in Turkestan, and in Central Asia. We find them again in the Libyan desert and Tripoli-tanien. On the Highlands of Iran this form of irrigation seems to be the most common, and such tunnels are called, in Persia *kandt*, in Beloochistan and Afghanistan, *kariz*. They are of great age, probably hundreds of years.

CLIMATIC CONDITIONS AND LIMITS OF DISTRIBUTION.

Having discussed the soil adapted for the date-palm, as well as its water supply, we turn to the climatic conditions governing its distribution, of which two factors really are of absolute importance—heat and atmospheric moisture. Of these the latter especially is the more important in circumscribing its zone. In regard to temperature the date-palm seems to be very adaptable, since the zone of the earth where it is at home is characterized by an excessive climate and partially by sudden and violent changes of temperature.

Date culture is still possible in localities where the winter temperature falls below -5° or 6° C. (23° to $21^{\circ}.2$ F.), and where snow-fall occurs. More than once the palms of Laquat, in Algeria, for instance, have been seen bent under a load of snow, which remained on them for half a day.

In consequence of frequent frost all experiments with oranges and lemons have failed, but the date-palm seems to thrive admirably. In the oasis El Abiad Sidi Scheikh, at least 830 meters elevation, ice is repeatedly formed every winter, with a temperature of -3 C. ($26^{\circ}.6$ F.), without hurting the palms; and even farther south, in the dunes region of Areg -5° C. (23° F.) has been observed.

In the oasis Brizina, which is watered by the Wedseggeur, the water is often frozen

at noon. Even in the oasis of Biskra, only (about 400 feet) 125 meters elevation, the temperature goes below -2° to 3° C. ($28^{\circ}.4$ to $26^{\circ}.6$ F.), and ice 4 millimeters thick is formed. In the oasis Tuggurt, situated still farther south, the expedition of 1853 observed, after terribly hot days, a temperature of 3° C. at sunrise. In Murzuk (Fezzan) Rohlf's observed not only a temperature of $24^{\circ}.8$ to 23 F. in December and January, but also a lowering of temperature below the freezing point, for twenty-four days in succession, right in the middle of the town. In Bagdad 5° R. (23° F.) was observed three times by the traveler Michaux during 1872. Also in the oasis of Khur and Tebes, the most northerly of the highlands of Iran, frost is not at all unknown. It is therefore seen that the date-palm may quite well endure a temperature below the freezing point of water, only it must not last too long, or occur at the time of the development of the flowers or during the ripening of the fruit. Cases on record are not wanting of localities formerly adapted for the date that have become too cold, through some climatic changes, for instance, between Ispahan and Yezd.

Unusually hard winters, as 1871-72, destroyed a great many palms in Persian Beloochistan. Snow for the first time in the memory of the inhabitants had covered the whole heights of Maschkid elevation, 1,300 meters (one meter is equal to 3.2808 feet).

The inner part of Beloochistan is on the whole very cold at this elevation, and the icy north winds are dreaded very much by the inhabitants. It seems that even in these localities, where the date has its most northerly and elevated limit, the date culture must still be paying. On account of the excessively high summer temperature, of long duration, the sugar content of the date is very high.

The flowering commences in April and the dates are ripe in November. Though seemingly so well adapted to date culture, a too great lowering of temperature does occur, but at very long intervals, destroying the palms totally, or at least the productiveness for years. These occurrences can, however, only be compared with similar ones in parts of Asia Minor, by the Dardanelles, or in Languedoc, where olive culture has similarly been injured. It may be laid down as a rule that the culture of dates may be carried on in a country where the temperature for a short time falls as low as -6° C. ($21^{\circ}.2$ F.), and that the growing of the palms is still possible in a climate where an occasional lowering of the temperature to -10° C. (14° F.), for instance, in Nizza and Bordighera (Italy), where the palm often enough has to endure a temperature of -8° C. ($17^{\circ}.6$ F.) to 9° C. ($15^{\circ}.8$ F.), however, rapidly disappearing. Still less sensitive is the date-palm to heat. In the same countries of which we have just spoken as subject to the occurrence of surprisingly low temperatures, the climate is marked by very high summer heat. In Biskra as high a temperature as 48° C. in the shade occurs; in Rhadames (oasis in North Africa) 50° C. (122° F.), and in the oasis Kanar the regular noon-day temperature rises to this. In the highlands the heat is probably not any less. Colonel MacGregor observed in the oasis Khur, in the middle of May, 45° C. (113° F.), and Bunge in Tebes, in November, $27\frac{1}{2}^{\circ}$ C. (83° F.) in the shade, and $37\frac{1}{2}^{\circ}$ C. (99° F.) in the soil.

We see, therefore, that the date-palm is exposed to a yearly change of air temperature of 60° C. (140° F.), or even as much as 70° C. (158° F.) in soil temperature. Even in the course of a day it has to go through great changes, for a daily change of 20° C. (68° F.) is almost a rule. In the Algerian Sahara a change of wind has been followed by a change of temperature of 40° C. (104° F.) We shall therefore not err much when we estimate daily changes of temperature at from 15° to 20° C. (59° F. to 68° F.), in Bagdad at 13° C. ($55^{\circ}.4$ F.), in Multan at 17° C. ($62^{\circ}.6$ F.)

It is remarkable that, unlike almost all other palms, the date-palm may endure such extraordinary changes of temperature. Closer examination proves, however, that it is only the stem and the foliage, the parts above ground, that are exposed to these violent changes, the roots being deep in the ground, where a comparatively steady and cool temperature prevails. Cosson found, for instance, the temperature of the desert sand 50° to 70° C. (122° to 158° F.), while at a depth of 1 decimeter (about 4 inches) it was only 25° C. (77° F.); the water of the wells dug in the creek beds 19° C. ($66^{\circ}.2$ F.) at most.

We have thus seen, on the one hand, that with an abundant water supply in the soil the highest temperatures do not hurt the date-palm; on the other hand, that a temperature of about -10° C. (14° F.) or below kills it. From this it must be presumed that its heat demand must be a very great one; that a certain high heat coefficient is necessary for the ripening of eatable fruit. De Candolle found that the heat coefficient* of $5,100^{\circ}$ of Celsius is necessary, and that the tree does not start growing below a temperature of 17° to 18° C. ($62^{\circ}.6$ to $64^{\circ}.4$ F.). When this degree of heat is first reached (which in the case of the oasis of Biskra is at the end of March) the date-palm commences to develop its flowers, the fertilization following at a temperature of 20° to 25° C. (68° to 77° F.). The conclusion from observations of the temperatures in the various date countries is that when the total heat of the growing season from flowering to fruit-ripening does not reach $5,100^{\circ}$ the fruit of the date does not become fit to eat; it may become fertile, but remains hard and tasteless, wanting in starch and sugar, consequently in the nourishing qualities. The higher the total heat is the more does the date possess these qualities and the shorter time passes between flowering and fruiting.

The following mean temperatures from various cities of the date region and immediately adjoining are interesting: In Cairo the average temperature of the year is $21^{\circ}.7$ C. ($51^{\circ}.1$ F.), while that of the months which elapse between flowering and fruit-ripening, March, November, is $24^{\circ}.1$ C.; in Alexandria, the mean of the year only $21^{\circ}.2$ C. (about $69\frac{1}{4}^{\circ}$ F.), the latter $22^{\circ}.9$ (about 73° F.); in Biskra, $22^{\circ}.5$ C. (about $72\frac{1}{4}^{\circ}$ F.), the latter $25^{\circ}.4$ (about 73° F.); in Algeria, $20^{\circ}.6$ C. (about 69° F.) and $22^{\circ}.4$ C. (about 72° F.); in Palermo, $17^{\circ}.6$ C. ($63\frac{1}{2}^{\circ}$ F.) and $19^{\circ}.6$ C. (about 67° F.); in Murcia, 17° C. (about $62\frac{3}{8}^{\circ}$ F.) and $19^{\circ}.4$ C. ($66\frac{3}{8}^{\circ}$ F.); in San Remo, Spain, the most northerly limit of the date-palm's occurrence, $15^{\circ}.9$ C. ($60\frac{3}{8}^{\circ}$ F.) and $17^{\circ}.8$ C. (about 64° F.). We see, therefore, that the average temperature of Alexandria, where the date still ripens regularly, rises above the 21° C. ($70^{\circ}.7$ F.), while that of Algiers remains below it; on the other hand, that the temperature from March to November in Alexandria is $22^{\circ}.9$ C. ($72^{\circ}.5$ F.), and in Algiers $22^{\circ}.4$ C. ($72^{\circ}.60$ F.). From this we may well presume that the northern limit of successful date culture, so far as it is dependent on temperature, is marked by a lowering of the average temperature of the year below 21° C. ($69^{\circ}.8$ F.) and that of the temperatures of the nine months, March to November, below 23° C. ($73^{\circ}.4$ F.). Nevertheless there are exceptions to this, as will be seen later. While the average temperature of the year may generally be an approximate guide, it is really the temperature of the growing season, in which the date-palm passes through the whole process of its (vegetative) development, that is important. These eight months may even be shortened if the heat in less time is so much higher.

That, however, the heat is by no means the sole determining factor in the climatic conditions, but that dryness of atmosphere is a most important one, is best illustrated by the fact that as far north as Elche (Spain) fairly well-flavored dates may be raised. Elche, the most northerly point where dates are grown, has a very peculiar climate. It lies in a part of Spain which is remarkable for the clearness of the atmosphere and scarcity of rain, so that hardly any culture of the soil is possible without irrigation. It has, outside of North Africa, the least rain and the driest air of any country of the Mediterranean region eastward of the small Syrtis and Murcia, and is rather well named, being called "El Reino Serenissimo." It has a gypseous and marly soil. Outside of the irrigated oases only a vegetation of a sandy steppe is produced. The temperature in Murcia ranges from $44^{\circ}.8$ (about 112° F.) in summer to 5° C. in winter, and an average winter temperature of 10° C. (50° F.) stands against one of 24° C. ($72^{\circ}.02$ F.) in the summer. The wind changes regularly in spring southeast, northeast, taking the place of southwest, northwest. The rainfall is on an average 367 millimeters, and there are years when only 260 millimeters (8 to 9 inches) have fallen. The quick, violent showers are generally soon followed by clear, dry weather. The relative moisture of the air is only 60 per cent. on an average, rising in January to

* Summary of the daily average temperature.

69 per cent., sinking in June to 50 per cent. The yearly evaporation is 21.11 millimeters against 22.99 in Cairo. Hot, dry winds are frequent. Here we have, then, and here alone in Europe, a climate that might be called mild Saharan. We find here, also, everything African—numerous plants indigenous to the Sahara and Algeria.

The description of this is not unlike that of the climate of the interior part of California, especially in the southeast, and it is interesting to learn that this region fulfills the heat requirements of the date perfectly, taking the above-stated data as a basis. According to the temperature tables computed by the Central Pacific Railroad at their various stations (published in the Pacific Rural Press, February 4, 1882), the temperature at Delano, a station southeast of Tulare Lake, during the twelve months of 1878-'79 averaged $65^{\circ}.39$ F. = $18^{\circ}.55$ C.; for the seven months, April to October, $76^{\circ}.71$ F. = $24^{\circ}.80$ C., making a total heat coefficient for the seven months of $5,297^{\circ}.20$. In 1879-'80, for twelve months, $68^{\circ}.82$ F. = $20^{\circ}.40$ C.; for seven months, $80^{\circ}.84$ F. = $27^{\circ}.10$ C., making a total of $5,799^{\circ}.40$ C. At Fresno City, during the years 1878-'79, we have for the twelve months $69^{\circ}.45$ F. = $20^{\circ}.86$ C.; for the seven months, $79^{\circ}.90$ F. = $26^{\circ}.60$ C., and a total of $5,682^{\circ}.40$ C. In 1879-'80, for the twelve months, $65^{\circ}.51$ F. = $18^{\circ}.60$ C.; for seven months, $76^{\circ}.21$ F. = $25^{\circ}.10$ C., making a total for seven months of $5,253^{\circ}.70$ C.

In many localities in the southern part of San Joaquin Valley an equally high temperature prevails during the summer. Farther north the length of the season diminishes sensibly; and although we have seen that early dates may mature as far north as 38° northern latitude, yet 36° northern latitude will most likely be the northern limit in California for successful date culture on a large scale. From this southward to as far as where the summer rains become too abundant, seems to be the most promising territory in the northwestern hemisphere; for, as has been remarked before, abundant atmospheric moisture during the flowering and ripening season invariably marks the limits for successful date culture in the eastern hemisphere.

Nearly all the regions we have had occasion to speak of as date countries are more or less inside the influence of desert climate: thus the North African States bordering the Sahara, Egypt, and Nubia, as far south as latitude 15° north, south of which we enter into a zone more or less characterized by summer rains, gradually passing to the equatorial summer rainy seasons, which put a complete stop to the culture of the date-palm as a fruit tree. The rain-fall, even during the winter, is in these African countries extremely scanty and irregular, and failure for two years is by no means rare in the oases of the Sahara; while the almost total absence of rain on the east coast of Egypt restricts the culture to but very few localities.

The Arabian west coast, on the contrary, is blessed with considerable moisture during November, December, and January, and in consequence of this date culture flourishes in many localities along the coast of the Red Sea. Southern Arabia also is characterized by plentiful rains, making culture of coffee and other tropical fruits the most profitable; and date culture recedes from the coast to the high table-lands of the interior, where it reaches its greatest proportion, although carried on more or less in places along the south coast; and in the southeastern corner of Arabia (Oman) it assumes again chief importance. The eastern Arabian coast has a very scanty supply of rain, so that date culture is prevented by this cause and only carried on in favorable localities. When we reach the upper part of the Persian Gulf we meet with

abundant winter rain, especially so in Mesopotamia, where we have another important center of date culture. The rains fall here chiefly from December to March, and are in lower Karun sufficient for the culture of wheat without irrigation.

In Farsistan, Laristan, and Kirman (all provinces of Persia) the amount of rain varies according to elevation, but the fall is during the months from November to March, while in the oasis of Tebes, the most northerly point in this longitude, where date culture is of great importance, spring rains, though apparently very scanty, do occur.

In Mekran (Southern Beloochistan) as well as in Upper Beloochistan, it rains regularly in winter, while in Seistan (Afghanistan), where formerly date culture was carried on, and traces of a once flourishing country are found, the scanty rains seem chiefly to fall in the spring.

In India date culture of any importance is found only in the northwest (Punjaub), which is subject only to a limited amount of rain during the summer (compared with India) owing to peculiar conditions.

The summer monsoon blows in the Punjaub (Multan) from May to October, beginning as west-southwest, in June south-southwest, in July southwest, in August again resuming south-southwest, and ending in October with west-southwest. This monsoon carries much moisture, and date culture would be impossible if the mountains did not cause part of this to be precipitated near the coast, great heat of the plains preventing the rest from becoming rain. In the Punjaub there is, therefore, in spite of the monsoon, but scanty summer rains, especially in the south, and the rain-fall only increases when we get nearer to the Himalaya Mountains. The long dry season, the condition favorable for successful date culture, is, therefore, existing even here, the months of April and May, the time of blooming, and, still more, that of the fruit-ripening, October and November, being especially dry.

FINAL CONCLUSIONS.

When we consider the climates of all the regions mentioned as true date countries, we see, as before remarked, a striking resemblance to that of the southern part of the Pacific States, and after what we have learned of local trials here it seems almost beyond question that date culture must at some future day become an important enterprise in many regions now considered comparatively worthless. The date would fill a blank in the list of our wonderfully diversified products with a crop of the more importance because of its peculiar requirements, which are such that it, in a large measure, need not transgress on the province of any other fruit tree or cereals.

It would thus seem that the encouragement of date culture in suitable localities should engage the attention of the Government. The first step to be taken would be the introduction of the early varieties from Spain and the northern part of Africa and Persia. This, as will be remembered, can only be done by procuring sprouts (or suckers) from these varieties, or, what would be far better and safer, rooted plants grown from the sprout. If such plants were distributed to the proper parties we would doubtless have within five or six years some remarkable results.

Besides this, some experiments with hardy seedlings should be made in alkaline regions, in order to determine definitely how strongly charged might be the waters and soils in which the date-palm would flourish.

SUPPLEMENTARY.

By request of the author the following letter, which recently appeared in the San Francisco Rural Press, is here inserted :

LA PAZ, NEW MEXICO, *March 21, 1883.*

EDITOR RURAL PRESS, *San Francisco :*

My father, E. von Borstel, who is living on his hacienda, Los Dolores, in this Territory, requests me to communicate to you the following facts :

In an issue of your paper I have read with interest an article on dates, and as I already have more than 2,000 palms in excellent growing condition, I believe that my experience with them would be of service to your readers. My rancho covers three sitios de granada. Mayor (pasture parcels), about 27 English square miles, all coast, between 25° and 26°, the lowest temperature 55°; the highest 100°; about this time 58° to 70°. Diseases and mosquitos unknown. Rain as well as dew very scarce. The weather is constantly fine—almost too much so.

When, in the year 1870, I took possession of this rancho I found only two date-palms, which quite corresponds with what you say in your paper. These are from dates that the Jesuit fathers brought from Spain. Since 1877, the time I retired from my mercantile business, I have made Los Dolores my place of residence. I procured the best African seed, and planted in the month of July 350 date-pits. Of these, however, only 25 germinated. I obtained more seed, and planted first in pure sand. The results were grand, for, as previously stated, I have now over 2,000 palms in excellent growing condition. For the last two years I have been picking more dates than both myself and my workmen could eat. Last year a few palms gave me more than 100 pounds each, and this year I calculate on 4,000 pounds for sale; all this since July, 1877. The palms have now been in bloom for fourteen days. Abnormal characters occur also; for instance, a staminate tree has borne three bunches of fruit, and is now again covered with staminate flowers.

I would not recommend seed from Spain. My seeds planted in pure sand germinated in from thirty to forty days, and the palms usually give the first fruit in the third year, with certainty in the fourth, instead of in the fifteenth as in Egypt or in Spain. This naturally must be attributed to the favorable climate.

Much sand, a little water, and not too much salt are necessary for the first years. With *plentiful irrigation, however, the palm will thrive in a soil that contains even large quantities of alkali.*

Nothing must be trimmed off the young plants until they fruit, and even then with great care—only the dry and withered leaves.

It appears to me that my palms, as well as my olives, grow faster during the cool months than during the hot ones.

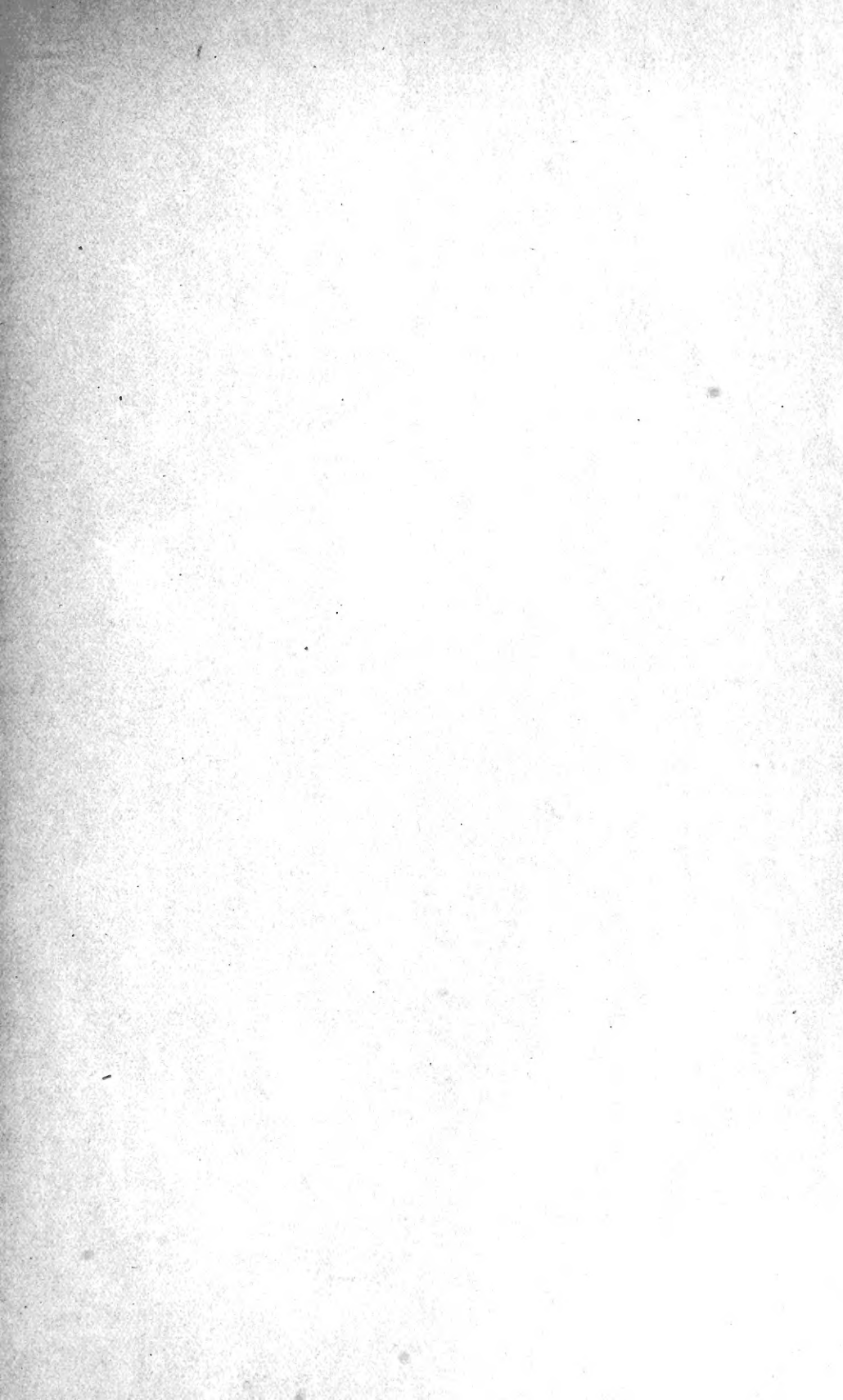
The 2,000 palms and about 1,000 olive and fig trees are watered by two pumps driven by wind-mills. The pumps are No. 1, of Jewell & Co., and the wind-mills are of the old Dutch fashion, with six sails instead of four, which we always can repair ourselves. I water every fourteen days, and each plant gets from sixty to eighty gallons of water. As soon as this is absorbed the whole circumference is loosened up by the hoe to a depth of about four inches.

In a cañon, about two miles from my palm and olive plantation, I have still another garden, with 20,000 grape vines and 400 fig-trees, watered by a spring which might run a turbine of at least twenty horse-power without disturbing irrigation in the least.

Use the above as may suit you, and if you wish further information on semi-tropical fruits I am always at your service.

Respectfully,

E. VON BORSTEL,
Per H. A. v. BORSTEL.





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