MISCELLANEOUS PAPERS.

The following papers, on Seedless Fruits, by Dr. E. L. Sturtevant, and a Calendar of the Flowering of Trees and Shrubs in 1880, by John Robinson, though not of a character for reading at the meetings of the Society, are deemed by the Committee of so much interest and value that they have much pleasure in adding them to the Transactions. Professor Robinson's Calendar is much fuller than any previous one, and he has encouraged the Committee to hope for a continuance of it in future years.

The Committee have also added a few letters which have been suggested by the discussions of 1879, and they would take this opportunity to acknowledge the obligations of the Society to the writers.

SEEDLESS FRUITS.

BY E. LEWIS STURTEVANT, M. D., SOUTH FRAMINGHAM, MASS.

Seeding is not an essential characteristic of individual plants, nor, under peculiar circumstances, even of whole groups of plants. We not only find in Nature productiveness varying among species, but often complete barrenness. Thus Brandis* states that the seeds of *Bambusa arundinacea*, Retz, and other species, have often saved the lives of thousands in times of scarcity, as in 1812 in Orissa; 1864 in Canara, and 1866 (probably *B. Tulda*, Roxb.) in Malda, while *B. Balcooa*, Roxb., he has never seen in flower. Humboldt† states that the *Guadua* in South America blossoms very rarely, and says that it is a very striking fact that some plants grow with the greatest vigor in certain localities without flowering, as is the case with the European olive trees introduced into America centuries ago and growing near Quito at elevations of about 9600 feet above the sea level. Bojer‡ states the same fact for the walnut, hazel-nut, and the fine olive trees of the Isle of France. The sugar cane, according to various observers, says Darwin,§ never bears seed in the West Indies, Malaga, India, Cochin-China, and

* Forest Flora, 566.
† Views of Nature, Bohn's ed., 335.
‡ Hortus Mauritianus, 1837, 201.
§ An. and Pl., II, 206, N.Y. Ed., 1868.

the Malay Archipelago. Fleischmann,* however, speaks of a West Indian cane bearing seeds, but these did not sprout. The sweet potato has never flowered in my garden in Massachusetts; it, however, is cultivated for its flowers, as well as for its root, in India,† but Mr. Fortune informed Darwin‡ that in China, so far as he had seen, it never yields seed. *Citrus aurantium*, Riss. et Poit., in Lower Bengal does not fruit at all, or does not bear freely. *Millingtonia hortensis*, L., seeds very rarely in North India, and the Indian *Populus alba*, L., does not often flower, according to Brandis.§ *Agave vivipera*, when grown in rich soil, invariably produces bulbs but no seeds, according to Dr. Royle.‖ *Dioscorea aculeata*, L.,¶ is said never to flower or fruit. Firminger** states that the quince had been in the Calcutta Botanic Garden for twenty years, and had never blossomed. Dr. Riddel states that the tree blossoms in some localities but does not produce fruit. Pear trees brought from America have blossomed abundantly every year, but nothing more, and apple trees, brought likewise from America, have blossomed often, but if they have set fruit, it has been only to drop it immediately afterwards. On the slopes of the mountains of Mexico, at Xalapa, says Humboldt,†† wheat does not form ears. Many alpine plants ascend mountains beyond the height at which they can produce seed. The *Acorus Calamus* extends over a large portion of the globe, but so rarely perfects its fruit that this has been seen by but few botanists. *Lysimachia Nummularia* so seldom produces seed-capsules, that Decaisne, who particularly studied this plant, has never seen it in fruit. The horseradish rarely perfects capsules.‡‡ Dr. E. Bornet, of Antibes, informed Darwin§§ that in hybrid *Cisti* the ovarium is frequently deformed, the ovules being in some cases quite absent, and in other cases incapable of fertilization. Darwin‖‖ also states that when stamens are converted into petals, the plant becomes on the male side sterile; when both stamens and pistils are thus changed the plant becomes completely barren. For this reason, double portu-

* U. S. Pat. Of. Rept., 1848, 283.
† Firminger, Gardening in India, 511, 157.
‡ An. and Pl., II, 206.
§ Forest Flora, 53, 347, 474.
‖ Trans. Linn. Soc., XVII, 563.
¶ Seemann, Flora Vitiensis.
** Gard. in India, 245.
†† Travels, Bohn's ed., I, 498.
‡‡ For other instances see Darwin, An. and Pl., II, 207, 208.
§§ An. and Pl., I, 467.
‖‖ Ib., II, 204.

lacas have a great paucity of seed, and according to Breck * hardly a capsule of seed is to be found on a plant. In India, *Hibiscus Rosa-Sinensis*, according to Firminger,† is never known to produce seed, and this is also the case with *H. liliiflorus*.

Other instances of plants not producing seeds are to be found amongst the diœcious species when the two sexes borne on different plants are separated. Thus Theophrastus,‡ in the fourth century before Christ, observed that palm trees do not bear fruit unless the females are fecundated by the dust contained in the flowers of the male, and that in Greece the palm trees raised for the ornament of gardens bear no dates, or at least never bring them to perfect maturity. This process of fertilization, according to Stocks,§ is now performed in Sindh, in Arabia, and elsewhere, by making a hole in the sheath of the female flower, before the flower-sheaths open, and placing therein a few bits of the male panicle.

These illustrations seem to be sufficient to establish our proposition that seeding is not an essential characteristic of plants; that plants in nature and under art, *can* flourish, and yet, as a general thing, produce no seed, and hence it is *a priori* probable that the habit of producing seed can be changed, amended, or destroyed through the artificial processes involved in the act of domestication and cultivation.

Further, seed-bearing seems but a device for the propagation of plants, and in nature is so general a characteristic, because offering such a valuable provision for the action of natural selection in perpetuating the species. It is only when some other provision takes the place of this device of seeding, that a barren plant can exist as a species. Hence, in those cases where propagation is more readily effected in other ways than by seed, we observe a lessening of fertility, and an approach to or a complete barrenness. Perhaps we should add, although really included in the above, that the conditions of life affecting the new plant, may determine against the seedling and in favor of the bulb, the tuber, the runner, or the offset. The antithesis to natural selection is that useless parts have a tendency to disappear, and hence as the seed loses its importance, it is apt to lose its functions and identity. This fact is otherwise expressed by Goethe and Geoffrey St. Hilaire, viz, that when one part of a plant is unduly nourished, other parts

* New Book of Flowers, 39.
† Gard. in India, 412.
‡ Hist. Plant., Lib. 2; Lib. 3, cap. 5.
§ Hooker's Jour. of Bot., VII, 551.

become reduced, and this is called the law of compensation or balancement of growth.

Thus; the potato ceases to produce seed-balls freely as the tubers become improved by cultivation, as is generally known, and is especially illustrated in the experience of the well-known propagator, C. E. Goodrich.* The Bogota potato, when first introduced, bore small tubers, and was covered with fruit; twenty years later it produced enormous tubers, but did not even set, much less perfect seed. Thomas Andrew Knight† says he has shown that the cause why early varieties of the potato do not afford blossoms, is the preternaturally early disposition of the plant to generate its tuberous roots. The varieties of radish, says De Candolle,‡ with small roots, yield numerous seeds valuable for containing oil, whilst the radishes with large roots are not productive in oil-bearing seeds. In one instance, I removed a young beet plant, a biennial, from a rich to a sterile soil, and subjected it to conditions interfering with its vigor, and the root grew to but small size, but a seed-bearing shoot was thrown up. In several instances by continually checking the growth of the cabbage by quite frequently pulling upon the small plant until I could feel the fibres of the root yield I produced rapid "heading," and the appearance of the seed-stalk the first year. The maize plant, under excessive manuring, I have found to grow with great luxuriance, and to be productive mostly of deformed ears of grain, and but a small crop. To make European vegetables under the hot climate of India yield seed, says Ingledew,§ it is necessary to check their growth, and when one-third grown, they are taken up, and their stems and tap-roots are cut or mutilated. Prof. Lecoq‖ had three luxuriant and sterile plants of *Mirabilis*, but after beating one with a stick until only a few branches were left, these at once yielded good seed. Seedling fuchsias, says Burbidge,¶ if starved, frequently flower when only an inch or two in height. M. J. Berkeley** says that those persons who undertake to supply good turnip seed, check the luxuriance of the roots by repeated transplanting, as it is found that seeds raised from the finest roots produce plants which have a tendency to make a luxuriant head rather than a large and sound root.

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* Trans. N. Y. Ag. Soc., 1848, 418.
† Hort. and Phys. Papers, 321.
‡ Mem. du Mus., VII, 178, quoted by Darwin, An. and Pl., II, 412.
§ Trans. of the Agri-Hort. Soc. of Ind., II, quoted by Darwin.
‖ De la Fécondation, 1862, 308, quoted by Darwin.
¶ Cultivated Plants, 91.
** Treas. of Bot., II, 1082.

Joseph Harris, of Rochester,* says "You can raise more plants from an ounce of *poor* cabbage, onion, lettuce, carrot, parsnip, and beet seed than you can from an ounce of the best and choicest," as there seems an antagonism between the functions of seed production and of growth. John Morrison† writes that there are numerous instances where turnips, when young, have received a check by frost, and run to flower instead of bulbing. The *Solandra grandiflora*, a Jamaica shrub, for years grew vigorously in English stoves, without showing any signs of fructification. By checking the luxuriance of the growth it is now caused to flower abundantly.‡ An analogous illustration is the surprise expressed by Koelreuter§ that sterile hybrids show a strong tendency to develop gigantic or tuberous roots, and almost invariably tend to increase largely by suckers, etc.

These are sufficient illustrations of antagonism of growth between root development and seeding, and leaf-growth and seeding. We will now pass to the antagonism that appears to exist between the development of the various parts of the fruit, confining ourselves to the species which are normally, or in varieties, or individually, seedless, and using the term fruit in the cultural, and not in the botanical sense.

The Apple, *Pirus malus*, L., is a fleshy fruit consisting of the ovary and calyx. The outer skin, or epicarp, is composed of the epidermis of the calyx combined with the ovary; the fleshy portion is the mesocarp, formed by the cellular portion of the calyx and ovary; while the scaly layer forming the walls of the seed-bearing cavities in the centre, is the endocarp. The carpels lie in the centre of the fruit, and form the core, while the edible pulp is formed by the calyx, which is adherent to the exterior of the ovary. The calyx is a modification of the leaf structure, or morphologically is related to the leaf.

The better varieties of the apple usually contain some abortive seeds, and are individually to be found seedless. As a rule, to which as yet I have noted no exceptions, the larger the apple the greater the number of abortive seeds. Thus five Baldwin apples,

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* Seed Catalogue for 1880, p. 1.

† Prize Essays Highland Soc., 4th Ser., II, 101.

‡ Quarterly Journal of Agriculture, I, 294.

§ Bastarderzegung, 5, 527, quoted by Darwin.

weighing thirty ounces, had eleven plump and nine abortive seeds; five other Baldwins from the same barrel and weighing seventeen ounces, furnished twenty-five plump and three abortive seeds. It also appears to be a fact that in general the improved varieties of apples contain fewer seeds and a larger proportion of abortive seeds than do wilding apples; and there is strong reason to suppose that apples of high quality, especially if ripening up soft, contain fewer plump seeds than do inferior varieties, but I have noted exceptions. Lunan* says that in Jamaica the fruit seldom contains seed, and no apple yet introduced thrives. The curious St. Valery apple in France, says Darwin,† although it bears fruit, rarely produces seed. At the Massachusetts Horticultural Society's Exhibition in 1834, a curious apple produced without blossom, and having neither core nor seed, was exhibited.‡ Mr. Knight§ grafted the apple upon a pear stock, and the fruit thus obtained had not a single seed. In a case reported in France of a seedling apple, one half of which was red and acid, the other half green and sweet, there was said to be scarcely ever a perfectly developed seed.‖ Individual apples are frequently seen with all the seeds abortive, and the Romans are said to have had one sort without kernels.¶ Yet in these instances of seedless fruit, we have but a hint of improvement in quality accompanying barrenness.

The BANANA is a prominent instance of a seedless fruit. The fruit is composed of three adherent carpels, surrounded by the external coat of the ovarium. It belongs to the genus *Musa*, and is conveniently described as forming a number of species. This fruit, according to Humboldt,** has been constantly cultivated as far as history and tradition extend, in all continents within the tropical zone. As is well known, it rarely produces seeds. On the coast of Paria, however, near the Golfo Triste, the banana is said to occasionally produce germinating seeds if the fruit be allowed to ripen on the stem. At Bordones also, near Cumana, perfectly formed and matured seeds have been occasionally found in this fruit. In the Province of Cercado, on the Amazon, "there is an enormous amount of kinds or varieties of bananas which produce in the year from seed."†† It is doubtful whether this does not

* Hort. Jam., I, 24.
† An. and Pl., II, 203.
‡ Hist. Mass. Hort. Soc., 234.
§ Phys. and Hort. Papers, 222.
‖ Loudon's Gard. Mag., XIII, 230.
¶ Hort. Trans., I, 152.
** Views of Nature, 305.
†† Castelnau's Travels.

refer to the yield from the planting of suckers, however. Meyen* states that at Manilla one variety of the banana is full of seeds. Capt. Cook arrived at Batavia in December, 1770, and describes the bananas there. After mentioning several varieties he says "there is one which deserves the particular notice of the botanist, because, contrary to the nature of its tribe, it is full of seeds. . . . It has, however, no excellence to recommend it to the taste, but the Malays use it as a remedy for the flux."† Burton‡ says of Central Africa that the best fruit plantain is that grown by the Arabs at the Unyamyembe; it is still a poor specimen, coarse and insipid, stringy and full of seeds. . . . Upon the Tanganyika lake there is a variety called "Mikono t'hembro" or Elephant Hands, which is considerably larger than the Indian "Horse Plantain." The skin is of a brick-dust red, in places inclining to rusty brown; the pulp is a dull yellow, with black seeds, and the flavor is harsh, strong, and drug-like. Roxburgh § says the original wild *Musa* from which all the cultivated varieties of both plantain and banana proceed, bears numerous seeds. The fruit is soft and pulpy. In the Himalaya, Hooker‖ mentions two species that ripen austere and small fruits, which are full of seeds and quite uneatable. The fruit of *M. ensete*, Bruce, is not palatable and is rarely eaten, and contains a few large stony seeds. It is grown in large plantations, in Abyssinia, for the inner part of the stem and the young spike, which are served as a table vegetable.¶ *M. glauca*, Roxb., of Pegu, never produces suckers. The fruit contains little else than seeds, not fit for a monkey to eat.** *M. Nepalensis*, Royle, is found in Nepal, growing apparently in a wild state, and the fruit containing little else than the hard dry seeds.†† *M. superba*, Roxb., a native of Southern India, ripens seed which is fertile. The fruit is of no use; when ripe it is more like a dry capsule than a berry. It never produces suckers.‡‡

The seedless species are: *M. Arakanensis*. The fruit of this

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* Reise um Erde, II, 214, quoted by Darwin.

† Cook's Voyages, I, 304.

‡ Lake Regions of Central Africa, 316.

§ Coromandel Plants, plate 275.

‖ Himalayan Journals, I, 183.

¶ Unger, U. S. Pat. Of. Rept., 1859, 352. Masters, Treas. of Bot., II, 765.

** Roxburgh, Coromandel Plants, pl. 300.

†† Royle, Illust. of the Bot. of the Himalaya Mts., 355.

‡‡ Roxburgh, Coromandel Plants, III, 18, 96.

plantain is one of the best there is; the old trees yield particularly fine fruit. In 1857, eighteen varieties were sent to the Agri-Horticultural Society of India.* *M. Chinensis*, syn. *M. Cavendishii*, is a very rich and delicious fruit, now grown in Florida, and the variety best suited for greenhouse culture. *M. paradisiaca*, of the Siamese countries, has many varieties.† *M. rubra* is the "Vai" of Cook, and the "Fahie" of Wilkes. The fruit, which grows upright, is of a deep golden hue with orange-colored pulp, destitute of seeds, tasting like the common banana but of a higher flavor, and very popular with the natives of Tahiti.‡ "The Ram Kela," of India, has fruit of a very dark red, ripening to a yellowish red, remarkably fine.§ *M. Fei*, the "fei," a wild plantain of Tahiti, of which there are five varieties, is usually eaten either roasted or boiled.‖ *M. sapientum*, the species to which some botanists refer all the others as varieties, has many varieties. Firminger¶ describes seven in culture about Calcutta. Simmonds** says there are twenty varieties in Tenasserim, ten in Ceylon, and thirty in Burma. In Madagascar the plantains are about as large as a man's arm. The "Staff of Life" in Central Africa has about a dozen varieties. Burton†† says it is "scarcely ever eaten in the ripe state, save by the females who extract from it an unfermented and delicious liquor."‡‡ Grant §§ says it is the staple food of the countries one degree on either side of the equator. There are half a dozen varieties,—the boiling, baking, drying, fruit, and wine-making sorts. The dried fruit from Ujiji is like a Normandy pippin. At Tongataboo, Cook found fifteen different varieties,‖‖ and at Atooi, in February, 1778, at least five or six varieties.¶¶ Acosta*** says "there is a kind of small plants, white and very delicate, which in Hispaniola they call Dominiques. There are others which are stronger and bigger, and red of color." This seems to be the *M. maculata*, Jacq., and *M. regia*, Rumph. Humboldt says††† the *Musa* has as great a variety of fruit as our apple and pear trees. *M. troglodytarum*,

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* Firminger, Gard. in India, 181.
† Pickering, Chron. Hist. of Pl., 277.
‡ Wilkes, U. S. Exp. Ex., II, 28.
§ Firminger, Gard. in India, 180.
‖ Voy. of the Novara, III, 263.
¶ Gard. in India, 177.
** Trop. Agr., 457.
†† Lake Regions of Central Africa, 316.
‡‡ Long, Cent. Africa, 126.
§§ Speke's Nile, 583.
‖‖ Cook's Voyages, II, 127.
¶¶ Ib., II, 246.
*** Natural and Moral Hist. of the East and West Indies, Eng. Trans., 270.
††† Travels, I, 49.

L., syn. *M. uranoscopus*, Rumph., of India and the Pacific Islands, has fruit, like *M. rubra*, on upright stalks, small, reddish or orange colored, and edible.*

These statements bear out Balfour's inference† that in the case of bananas and plantains, the non-development of seeds seems to lead to a larger growth, and a greater succulence of fruit, and we might add quality also.

The BARBERRY, *Berberis vulgaris*, has a stoneless variety called Vinetier Sans Noyau by the French, but the plant frequently produces berries with seeds, as Downing‡ observes. R. Thompson§ says this stoneless fruit often occurs on old plants, and a celebrated conserve is made from it at Rouen, France. I have occasionally found seedless fruits on hedge plants in Maine. This fruit is botanically a berry with a few seeds.

The BEECH tree, *Fagus ferruginea*, Ait., I have never known to produce nuts with a kernel, in Framingham, Mass. It forms the sterile fruit often in great abundance. I am told, however, that in groves it sometimes perfects the nut.

The BREAD-FRUIT, *Artocarpus incisa*, L. fil. The edible portion is formed by the cohesion into a single mass, of the floral envelopes and ovaria of a large number of flowers, arranged on a central fleshy column or spike. It is nowhere met with growing wild, (?) and has been distributed from the Moluccas, by way of Celebes and New Guinea throughout all the islands of the Pacific Ocean, to Otaheiti. It is also naturalized in the Isle of France and tropical America,‖ and bears fruit in Ceylon and in Burma.¶ On a single Polynesian island twenty-four varieties are enumerated, as Darwin** writes. In Otaheiti, writes Lunan,†† they reckon eight varieties without seeds, and one variety with seeds is inferior to the others, and this sort is not good unless it is baked. The seeds are said by Wilkes‡‡ to be often abortive in Tahiti. The natives of the Pacific Islands possess, says De Candolle,§§ many varieties, notably

* Mueller, Select Plants.
† Botany, p. 261.
‡ Fruits, ed. of 1866, 284.
§ Treas. of Bot., I, 136.
‖ Unger, U. S. Pat. Of. Rept., 1859. 315.
¶ Brandis, Forest Flora, 426.
** An. and Pl., II, 309.
†† Hort. Jam., I, 113.
‡‡ U. S. Exp. Ex., II, 50.
§§ Geog. Bot., 919.

those whose fruits are without seeds, which indicates a very ancient culture. M. Sonnerat, found in the Philippines, the bread-fruit wild, and bearing ripe seeds of a considerable size*. The plants are propagated by cuttings. They may also, says Williams,† be increased by suckers, which are produced abundantly in their native countries.

The Cherry, *Prunus*, sp. is formed by a change in the substance of the carpellary leaf. The internal surface of this becomes hardened into the stone (the endocarp), whilst the external (epicarp) remains as a thin cuticle or skin, and the pulp of the fruit (the mesocarp) is formed by the increase of the parenchyma or fleshy tissue of the leaf. Robert Manning, a skilled and accurate pomologist, informs me that the cultivated cherries have the seeds generally abortive. This is not always the case, however, as Prince's Duke was raised by Mr. Prince, of Long Island, from a seed of the Carnation,‡ and it is doubtless true that our principal varieties have originated from seeds of the cultivated kinds. Mr. Knight§ crossed the Morello and common cherry. From many thousand blossoms, five cherries were produced, and four of these did not contain seeds. The quality was excellent.

The Chestnut, *Castanea vesca*, L., does not readily and abundantly ripen its fruit in the immediate neighborhood of the sea, in Massachusetts, says Emerson.‖ Abortive nuts are very common in the burrs, and frequently in Framingham all the fruits on the tree are abortive. In the Chestnut, the abortion of some of the ovules seems to be an invariable and normal process.

The Cucumber, *Cucumis sativa*, L. The fruit consists of three carpels united together and forming one cell, but having the ovules arranged on three lines which pass up the sides.¶ Seedless cucumbers are mentioned by Loudon** as being grown purposely from unfertilized flowers on account of their more desirable quality. William Saunders, now superintendent of the garden and grounds of the Department of Agriculture, at Washington, tells me that

* Foster's Obs., 179, note.
† Choice Stove and Greenhouse Plants, II, 109.
‡ Downing, Fruits, ed. 1860, 274.
§ Phys. and Hort. Papers, 277.
‖ Trees and Shrubs of Mass., ed. of 1846, p. 165.
¶ Carpenter, Veg. Phys., Bohn's ed., 411.
** Horticulturist, 495.

this is a well-known custom, and E. F. Bowditch, of Framingham, Mass., has grown this seedless fruit in his cucumber house. The melon, which I have largely grown, I have never known to be seedless, but it is a matter of common observation with me that the fruits of the highest flavor and excellence are apt to contain fewer seeds than others of the same variety but diminished quality.

The DATE, *Phœnix dactylifera*, L. The epicarp is the outer brownish skin, the pulpy matter is the mesocarp, and the paper-like lining is the endocarp covering the hard seed. The tree is dioecious, and the female tree is fertilized artificially. Nineteen-twentieths of the population of Fezzan live on dates during nine months of the year. More than fifty varieties are there known, according to J. Richardson.* At Mooltan, P. Edgeworth states that there is one date tree called "Bedana" which bears a stoneless fruit, and in former times it was considered a royal tree, and the fruit was reserved for the reigning sovereign.† In the deserts of North Africa, the date palm has yielded, as Vogel‡ states, thirty-eight varieties.

The DIOSPYROS genus which includes the persimmon has occasionally seedless varieties. Forsyth§ mentions a cultivated variety of *D. melanoxylon*, Roxb., as being without stones. E. J. Wickson, editor of the *Pacific Rural Press*, writes me that some Japan persimmons, *D. Kaki*, L. fil., bear seedless fruit the first year; the second year seeds appear. "I cut one last week," he says (February, 1880), "ten and three-quarters inches in circumference, without sign of seeds." In Japan there exist some fifty varieties, thirteen of which Henry Loomis‖ pronounces as constituting the leading sorts. Of these the "Yemon" has some specimens seedless, especially when the trees are young. The quality seems to be excellent—superior to many, but not equal to the "Gosho." The *Diospyros Virginiana*, L., (Persimmon) is, as William Saunders informs me, frequently seedless. Occasionally varieties are met with having fruit double the size of the ordinary kind. The best ripen soft and sweet and have a clear, thin, transparent skin without any

* Jour. Lond. Hort. Soc., 1851, 46.
† Jour. of the Agri-Hort. Soc. of India, 1867, quoted by Firminger, Gard. in India, 173.
‡ Annals and Mag. of Nat. Hist., 1854, 460.
§ Highlands of Central India, 463.
‖ Scientific Farmer, June, 1879, 78.

rough taste, as Porcher* says. It is not, however, yet classed, among our cultivated fruits by the American Pomological Society. I. M. Pearson† says, "I have seen some of our native kinds without any seeds, of which the fruit was delicious."

The FIG, *Ficus Carica*, L., is an anthocarpous fruit, in which the axis, or the extremity of the peduncle, is hollowed, so as to bear numerous flowers, all of which are united in one mass to form the fruit. Dr. Presl‡ enumerates no less than forty varieties which are cultivated in Sicily. Dr. Robert Hogg § enumerates sixty-five varieties of figs. Even in the United States, one leading nursery firm offers twenty-five varieties in its list.‖ There are forty-two varieties enumerated in the London Horticultural Society's Catalogue,¶ and eighteen in the American Pomological Society's Catalogue of 1877. Many kinds of fig, says Brandis,** attain maturity with sterile seeds—that is, seeds in which the embryo has not been developed, and therefore fecundation is not an essential condition to the ripening of figs. The cultivated fig tree bears two sorts of fruit; in the spring early figs or "fiorones," and in the summer late figs which ripen in the autumn. In the "fiorones" male flowers are very rarely found, and the few which may be present cannot serve for fecundation, for they do not make their appearance until long after the female flowers, nor until the stigmates of the latter are dried and destroyed. Whether it be owing to this or some other cause, I have never yet, says Prof. Gasparrini, been able to find seeds with embryos in the "fiorones." The summer fruits on the contrary, have no male flowers, and yet a large proportion, I may say nearly all, of their ovaries become perfect—that is, furnished with embryos.†† It is for this reason Gasparrini is led to suppose that the embryo of the fig seed is developed without previous fecundation.

The GRAPE, *Vitis*, sp. is botanically a berry, an indehiscent fruit which is fleshy or pulpy throughout. The seeds nestle in pulp formed from the placentas. The berry is formed from the

* Resources of the Southern Fields and Forests, 387.

† Trans. Ill. Hort. Soc., 1878, 87.

‡ John Hogg, Hooker's Journ. of Bot., I, 182.

§ Fruit Manual, 3d ed., p. 102.

‖ Ellwanger & Barry, Desc. Cat. of Fruits, 1880.

¶ Downing, Fruits, 1866, 290.

** Forest Flora, 419.

†† Ann. des. Sciences, Sec. 3, Tom. V, p. 306.

ovaries alone. The ancients claimed a method of producing seedless grapes, which is thus given in the "Travels of Anacharsis":* "To obtain grapes without stones, you must take a vine-shoot and cut it lightly in the part which is to be set in the ground; take out the pith from this part, unite the two sides separated by the incision, cover them with wet paper, and plant it in the earth. The experiment will succeed better if the lower part, thus prepared, be put in a sea-onion before it is planted. Other methods are known to produce the same effect." As erroneous as this advice may seem, yet in the present age, Firminger, in a communication to the Agri-Horticultural Society of India,† says that he was informed by R. Solano, of Shahabad, that by scooping out the pith of the Litchi, the result was, the stone of the fruit became much lessened and the pulp consequently more abundant, and considerably improved in flavor. He also stated that a like result was produced on the grape vine in Spain. Gen. J. Jenkins also communicated to Mr. Firminger the following method of preventing the formation of seeds in guavas; "Take a young tree, split it in the middle with a carving knife, about twelve or fifteen inches up; pick out the pith, close it, cover it with earth and bind it up with straw. The tree will grow as before, but the fruit will have no seeds in them." But the general had never tried it.

In the grapery of M. H. Simpson, Saxonville, Mass., is a seedless variety of the Black Hamburg, of which I have frequently eaten the fruit. Yet even this vine occasionally produces seeds in some of the berries. William Saunders informs me that seedless grapes frequently occur in the graperies of the Department of Agriculture at Washington, when from any circumstance the pollen becomes excluded from the pistils. The Sultana grape is always a seedless variety, and is so advertised in our nurserymen's catalogues. Arnold‡ says, "In the way of eating there can be few greater pleasures than to devour the grapes of Kasveen on a hot day as one would currants in England. They are the small, stoneless grapes, which, when dried, are sold as Sultana raisins." The Zante currant is a seedless grape, and supplies the dried currants of commerce. E. J. Wickson writes me that "the

* Theoph., De Caus. Plant., Lib. 5, Cap. 5; Democr., Geopon., Lib. 4, Cap. 7; Pallad., De Re Rustic., Febr., Tit. 29; Colum., De Arbor., 9; Plin., Lib. 17, Cap. 21, T. II, p. 74; Traité de la Vigne, T. I, 29, are the references.

† Gard. in India, 170.

‡ Through Persia by Caravan, 151.

Corinth grape is quite apt to bring seeds, much to the disgust of our people in California, who are trying to make Zante currants. The Corinth does the same in Australia." The Arabians "dry a small sort of grape called 'Kishmish,' which has no stone, but only soft and almost impalpable seeds."* Ludovico de Varthema, in 1503–8, describing Reame, a city of Arabia Felix, says: "Here also is found a kind of white grape, which has no seeds within, than which I never tasted better."† The white wine of Ispahan, says Redding,‡ is made from a small white grape called "Kismish," which has no pips, perhaps first brought from the island of that name, noted for fine fruit, near Gombron. Near Atrascan, says Pallas,§ there is a grape with mere traces of seeds, so small and lying so near the stalk that they are not perceived in eating the fruit. "In Bulkh," says J. Harlan, ‖ "the sweetest and best wine grape is called 'Kishmish;' it is a black, seedless fruit, of an oval shape, about the size of a person's first thumb joint. It differs in flavor, size, and color, from the Cabul grape of the same name." Among the grapes of Cabul is the "Ungoor-i-Kishmishee," a fruit not large, round, transparent, with a slight tinge of yellow, seedless, sweet, and luscious. The grapes of Eschol¶ "have generally a transparent membraneous seed, though some are said to have actually no seed at all, whereby, while they are chewed, no seed is discoverable to the taste or tongue, yet it is apparent when the grape is cut with a knife and seed is sought for." Le Bruyer** describes similar grapes without seed in Persia. In the Punjaub, according to Firminger,†† they have an indigenous stoneless grape, called the "Bedana."

It cannot have failed to be observed how a diminution in the size of the seed accompanies an improvement in quality in our native grapes. In the cases given, all the seedless grapes seem to be described as possessing an excellent quality. Is this a complete instance of the antagonism between seed and quality of pulp, which we have before inferred?

The GUAVA, *Psidium guajava*, Raddi. In this fruit the seeds nestle in pulp formed apparently by the placentas. The savory

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*R. Niebuhr, Travels through Arabia.

†Travels, Hakl. Soc. ed., 77.

‡Quoted in U. S. Pat. Of. Rept., 1860, 367.

§Travels, Eng. Trans., I, 313.

‖U. S. Pat. Of. Rept., 1861, 534, 529.

¶Calmet, Dict. of the Bible.

**Quoted by Calmet.

††Gard. in India, 212.

fruit, of the size of an apple, is highly relished, and is eaten raw or made into a conserve in the West Indies. It is covered with a rind of some thickness, within which are the seeds contained in a pulp without any shell.* The contained pulp is of white, red, or yellow color, in the varieties, full of bony seeds.† Its cultivation has been carried on by the primitive inhabitants of the main land of America, from Mexico to Brazil, from time immemorial, says Unger,‡ and it is frequently without seeds.

The KAKI. See Diospyros.

The MEDLAR. *Mespilus Germanica*, L. There is a variety called stoneless, without stones or seeds, advertised in French fruit catalogues.

The MULBERRY, *Morus alba* and *nigra*. The edible portion is formed by the cohesion, into a single mass, of the floral envelopes and ovaries of a large number of flowers, arranged on a central fleshy column or spike, the calyces becoming succulent, and investing the pericarps. This tree is but little cultivated in America, but in Asiatic countries it is in esteem. There are many varieties of *M. alba*, L., in Kashmere and Afghanistan, says Brandis,§ sweet and acid, and of all shades of color, from white to a deep blackish purple. The fruit furnishes a considerable portion of the food of the inhabitants in autumn, and much of it is dried and preserved. In Beloochistan, according to Stocks, there is a seedless variety called "Bedana." Harlan says,‖ the first fruit in the market at Cabul is the white, seedless mulberry or "Shah-toot," the thickness of the small finger. It is very sweet, and the tree is inexhaustibly prolific. In its season it forms the chief food of the poor. It is a grafted fruit. In Turkistan, the large white, almost seedless berries of the Khorasine mulberry from Khiva, both when fresh and dried, are greatly used for food.¶

The OPUNTIA *Davisii*, Engelm. Common on the upper Canadian, eastward and westward of Tucumcari Hills, near the *Llano Estacado*. All the fruit seen were sterile, and most of them elongated, one to one and a quarter inches long.**

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* Rhind, Veg. Kingdom.
† Lunan., Hort. Jam. I, 350.
‡ U. S. Pat. Of. Rep., 1859, 349.
§ Forest Flora, 407.
‖ U. S. Pat. Of. Rept., 1861, 529.
¶ Schuyler, Turkistan, I, 196.
** Engelman, Pac. R. R. Rept., IV, Bot. 49.

The ORANGE, *Citrus aurantium*, is botanically a hesperidium, or a berry with a leathery rind. This fruit consists of the carpels surrounded by the external coat of the ovarium, and having the space between their inner wall and the seeds they contain filled with a very succulent cellular tissue. The rind consists of epicarp and mesocarp, while the endocarp forms partitions in the interior filled with pulpy cells which are produced from the inner lining of the pericarp. The tree has been cultivated for its fruit from ancient times, and there are many varieties. According to Dr. Presl, there are fourteen cultivated in Sicily.* Loudon mentions nineteen varieties,† Downing twelve.‡ Gallesio describes forty of the principal kinds cultivated in Italy. Among the wild oranges of Florida even, I have noticed varieties. In one grove near Matanzas Inlet, I have found and eaten an orange with sweet pulp and bitter rind, and what is worthy of mention, the seeds are fewer and smaller in this variety than in the common bitter kind. D. J. Browne§ says that in many parts of the West Indies and South America, the wild oranges occur sweet and excellent, and sour and bitter, round, flattened, rough, smooth, obovate, pear-shaped, thick and thin skinned, juicy and dry,—some with and others without seeds,—some bearing seeds at the eye, outside of the fruit, while others present a navel-like protuberence at the same point, with no seeds. E. J. Wickson writes me from California: "I would state that the Navel or Bahia orange, now growing in this State is perfectly seedless." The St. Michael orange, says Browne,‖ one of the most delicious of all the varieties, is known by its small, seedless fruit, with a thin rind, and extremely sweet pulp. Loudon¶ says this variety "is generally without seed." Downing** says "the pulp often seedless, juicy, and often lusciously sweet." Dr. Bullar†† states that the thinness of the rind of a St. Michael orange, and its freedom from pips, depend on the age of the tree. The young trees, when in full vigor, bear fruit with a thick, pulpy rind, and abundance of seeds; but as the vigor of the plant declines, the peel becomes thinner, and the seeds gradually diminish in number, till they disappear altogether. "The myrtle-leaved orange," writes

* Hogg, Hooker's Journ. of Bot., I, 106.
† Hort., 608.
‡ Fruits, ed. 1860, 691.
§ U. S. Pat. Of. Rept., 1858, 266.
‖ Trees of America, 59.
¶ Hort., 608.
** Fruits, 694.
†† Balfour's Bot., 280.

Darwin,* "in my father's greenhouse, during many years, . . rarely yielded any seed, but at last produced one; and a tree thus raised was identical with the parent." Gallesio† asserts that when he impregnated the flowers of the common orange with the pollen taken from undoubted varieties of the orange, monstrous fruits were produced, which included "little pulp, and had no seeds or imperfect seeds." A Japanese orange, "Mushin tani nashi mikaw," is said to be seedless, and the trees thornless.‡

The PEACH PALM, *Guilielma speciosa*, Mart. The "Piritou" or "Piri Jao" of the natives, writes Humboldt,§ are very extraordinary; every cluster contains from fifty to eighty; they are yellow like apples, grow purple in proportion as they ripen, two or three inches thick, and generally, from abortion, without a kernel. Among the eighty or ninety species of palm trees peculiar to the new continent, . . . there are none in which the sarcocarp is developed in a manner so extraordinary. The fruit furnishes a farinaceous substance, as yellow as the yolk of an egg, slightly saccharine, and extremely nutritious. We found it cultivated in abundance along the Atabapo and the Upper Orinoco. Bates‖ says the "Pupunha" grows wild nowhere on the Amazons, but has been cultivated from time immemorial by the Indians. Bunches of sterile or seedless fruit sometime occur at Ega and at Para. Seemann¶ says the "Pupunha" of the Amazon, the "Paripou" of Guiana, has in most instances fruit whose seed is abortive, the whole fruit being a farinaceous mass. Occasionally, however, fruits are found containing the perfect, stony seed, and they are then double the usual size. The tree is not found wild in the Amazon districts, but is invariably planted. This palm is propagated, says Williams,** both by suckers and from seeds.

The PEAR, *Pyrus communis*, L., is botanically a pome, a fleshy fruit with the calyx adherent, and forming along with the epicarp or skin, and the mesocarp or pulp, a thick cellular mass, which is eatable, while the endocarp is scaly or horny and forms separate cells enclosing the seeds. Its varieties are extremely numerous.

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* An. and Pl., I, 404.
† Teoria Della Riproduzeoni, 69, quoted by Darwin.
‡ South. Cal. Hort., June, 1878, 292.
§ Travels, II, 336.
‖ A Nat. on the Amazons, 268.
¶ Popular Hist. of Palms, 208.
** Choice Stove and Greenhouse Plants, II, 212.

In 1842 more than seven hundred had been proved in the London Horticultural Society's Garden to be distinct. The Romans cultivated thirty-six varieties in the time of Pliny.* In Tuscany, under the Medici, in a manuscript list by Micheli of the fruits served up in the course of the year at the table of the Grand Duke Cosmo III, is an enumeration of two hundred and nine different sorts, and another manuscript of that time raises the number to two hundred and thirty-two, as Targioni-Tozzetti says.† Robert Manning, deservedly an authority on pears, informs me there is a variety without seeds, called Sans Pepins; that certain varieties, such as Vicar of Winkfield and Beurre Diel, have most of the seeds abortive; and that second crop pears are invariably seedless. M. Plumadore, Raleigh, N. C., writes me under date of February 17, 1880, "To my surprise the pears were seedless, having nothing but a small stem-like thread clean through the pear. On my expressing surprise, they said the reason was that they were the third crop that year. I cut several open to see if all were alike and found them all the same. These pears would average two and a half inches in diameter, and about three or three and a half inches in length, but a few were larger." This was in the autumn of 1877.

From a rather careful observation, I am disposed to believe that the more luscious or buttery the pear, the more frequent the abortive seeds, and certainly our improved varieties have fewer plump seeds than the fruit from seedlings.

The Persimmon. See Diospyros.

The Pineapple, *Ananassa sativa*, is a well-known instance of a seedless fruit. This is a multiple fruit, only the ovaries or pericarps never ripen any seeds, but all are blended with the floral envelopes, the bracts, and the axis of the stem they thickly cover, into one fleshy and juicy mass. The pineapple is indigenous in South America, and is now naturalized in many parts of the East Indies, in Surinam, etc.‡ Afzelius says § it grows wild in Sierra Leone, and are cultivated by the natives. It grows in vast abundance about Calcutta. Firminger‖ describes ten varieties, but does not

* M'Intosh, Book of the Garden.
† Jour. Lond. Hort. Soc., 1854, 159.
‡ M'Intosh, Book of the Garden.
§ Sabine., Hort. Trans., V, 461.
‖ Gard. in India, 174.

praise their flavor. A white kind which in the East Indies has run wild, is said by Unger* to still contain seeds in its fruit. Titford† says the pineapple grows wild in the woods of Jamacia. De Candolle‡ says the pineapple sometimes has seeds, for Piso mentions positively a pineapple growing wild in Brazil bearing many seeds, and Humboldt found pineapples of delicious quality, growing wild on the Orinoco, and often the seeds were not abortive. J. H. White, of Florida,§ says "new varieties are produced from seed, but I have never seen a seed, and probably have never seen an apple that contained one. . . . A plant obtained from seed requires a long time to fruit — one writer says under favorable circumstances twelve years — and when it does fruit the chances are in favor of its being worthless." There are many varieties: in 1768, Taylor described five sorts; in 1737, Miller described five; in 1769, Speechly spoke of fourteen; in 1822, Nichol of ten; in 1831, George Lindley of thirty-seven; in 1834, Rogers of nine; Mr. Munro, a more recent writer, of fifty-two.‖ Mr. White¶ says one European catalogue gives the names of fifty, and it is said that fifty-two have been fruited at Chiswick, England. The fruit of all the varieties grown in Florida, he continues, is yellow; that of other sorts is said to be purple, scarlet, green, white, and black; it is mostly conical, sometimes globular, and differs in form, flavor, and consistency, weighing from two to fifteen pounds. In the wild state, Balfour** says the fruit is more or less acid, but when cultivated it becomes sweet and highly aromatic. Sir R. H. Schomburgk says, "We have met during our journeys in Guiana considerable extent of ground covered with pineapples; but in their wild state they are small, seldom larger than an apple, of a bright yellow; and though their smell is highly aromatic (surpassing in that regard the cultivated species) they are stringy, full of seeds, and rather acidulous in taste."††

The Pistacia. *Pistacia vera.* At Cabul, as J. Hanlan writes,‡‡ the pistacia yields a crop of fruit one year, followed always by a crop

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* U. S. Pat. Of. Rept., 1859, 331.
† Hort. Bot. Am., 54.
‡ Geog. Bot., 926.
§ Cal. Hort., 1880, 42.
‖ M'Intosh, Book of the Garden.
¶ Cal. Hort., 1880, 42.
** Bot. 545.
†† Rawleigh's Dis. of Guiana., Hak. Soc. ed., 74, note.
‡‡ U. S. Pat. Of. Rept., 1861, 533.

of blighted fruit. The latter is like the former in external appearance, but is somewhat larger and quite destitute of kernel.

The PLUM, *Prunus Americana*, Marsh, is subject in New Brunswick to an anomalous form, which renders it seedless and inedible.* I have myself observed this appearance in Maine, the fruit becoming swollen, pulpless, seedless, and tasteless. Sometimes the remnant of an embryo is to be observed. This form seems more commonly to be produced when the spring season is cold and rainy. It is caused either by a fungus or the sting of an insect. The result is that the plum in this condition can hardly be called a fruit.† Darwin‡ refers to a form of the plum, *P. domesticus*, in which "the kernel lies in a roomy cavity surrounded only by the pulp" and called the stoneless plum. The varieties of *P. domesticus* are very numerous, some being bright yellow, green, almost white, blue, purple, or red. Downing describes one hundred and eighty sorts, and a leading nursery catalogue § offers a selection of one hundred and three kinds.

The POMEGRANATE, *Punica granatum*, L. A peculiar baccate, many-celled fruit, having a tough rind formed by the calyx, enclosing two rows of carpels placed above each other. The seeds are immersed in pulp, and are attached irregularly to the parietes, base, and centre. This pulp is apparently formed by the placentas.‖ On account of the profusion of its seeds, the pomegranate was with the ancients a mystical fruit, typifying procreation, increase, and abundance. It is found wild in Asia Minor, in Armenia, and in Central Caucasus, and Barnes found whole woods of it in Mazanderan.¶ In the Himalayas, it grows wild, and the fruit, though small, is offered for sale.** Barnes, in his "Travels in Bokhara," remarks on the pomegranate seeding in Mazanderan, as a remarkable peculiarity.†† Hasselquist‡‡ observed a variety in Cyprus with barren flowers, called "Balanistica." In India, the best fruits, having sweet juice and very small seeds, come from

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* Hooker's Journ. of Bot., III, 99.
† Dr. Harris in Hovey's Mag., VIII, 247; Dr. W. S. Farlow in New England Farmer.
‡ An. and Pl., I, 417.
§ Ellwanger & Barry, 1880.
‖ Balfour, Bot., 275, 262.
¶ De Candolle, Geog. Bot., 892.
** Royle, Illust. of the Bot. of the Him. Mts., 208.
†† Darwin, An. and Pl. II, 205.
‡‡ Voy. and Trav. in the Levant, 247.

Cabul.* Capt. Burton† describes three varieties which he met with in Arabia, one "Shamri" (Syrian), the best, a very sweet and superior fruit, almost stoneless, like those of Muscat, deliciously perfumed, and as large as an infant's head. The fruit is usually about as large as a full sized apple, having a hard rind of a yellowish color, and containing a pulp that is highly prized.‡ Sir A. Barnes mentions a "famous pomegranate without seeds, grown in gardens under the snowy hills near the Caubul River."§ "Seedless pomegranates from Djillabad" are enumerated among the fruits in the market of Cabul.‖ In 1860, cuttings of a seedless variety from Palestine, described as bearing fine fruit, much esteemed in Syria, were distributed from the U. S. Patent Office.¶

The Strawberry, *Fragaria*, sp. In this fruit the enlarged and conical receptacle bearing the pistils on its surface, becomes the edible portion in fruit. Of this esteemed fruit the varieties are endless. William Saunders informs me that he once had a bed of pistillate strawberries which fruited, but bore no seed, and that there were no other plants near from which fecundation could have been effected. A mule plant, says Thomas Andrew Knight,** from the Hautbois and Alpine strawberry, "blossoms very freely, and its blossoms set well; but the growth of the fruit subsequently remains very nearly stationary during the whole period in which the Hautbois strawberry grows and ripens, after which it swells and acquires maturity. It is then rich and high flavored, but of less size than the Hautbois, and without seeds."

In the above list, which we have extended somewhat to include the whole number of seedless fruits that we have collected, and wherein we have given such other information as will tend to show other conditions than the one of *antagonism* between the qualities of seedlessness and excellence of taste, we find either stated or inferred an improvement in quality accompanying seedlessness, or the lessening of seed-production, in the apple, the banana, the bread-fruit, the cherry, the cucumber, the date, the grape, the mulberry, the orange, the peach palm, the pear, the persimmon, the pine-

* Dutt., Hindoo Mat. Med., 166.
† Pilgrimage to El Medina and Meccah, I, 388.
‡ J. Smith, Dom. Bot., 368.
§ Firminger, Gard. in India, 260.
‖ J. Harlan, U. S. Pat. Of. Rept., 1861, 530.
¶ U. S. Pat. Of. Rept., 1860, 34.
** Phys. and Hort. Papers, 276.

apple, and the pomegranate. The exceptions appear to be the barberry, a fruit in but little esteem while raw; the beech nut, where seedlessness destroys its usefulness, as the seed is the part which is edible; the chestnut, wherein abortion destroys likewise the edible matter; the fig, concerning which as a seedless fruit we have collected few particulars; the guava, of which we have collected but little information; the medlar, of which we have found no reference to quality; the opuntia, a wild plant but little known; and the strawberry, of which we may say that it is probable that improvement in quality is accompanied by a proportionate lessening of the seeds. The pistacia, and plum, when seedless, appear to possess no quality whatsoever.

These fruits, using this term in a cultural sense, and excluding the edible seeds, are neither an essential to the plant nor to the seed. Like other unessential, yet generally present features, as the form of the floral envelopes, the coloring of the corolla, and the number of the leaves, the fruit is subject to a wide series of variations in size, color, and shape. It seems formed from the part of a plant peculiarly subject to modification, and apt to record the influence of external impressions; that portion of the plant which is of limited duration, and which must speedily fill its part. It is accessory to the seed only, and is concerned more with the province of the protection and distribution, than with the development. The apparent exceptions are the grape, guava, and the pomegranate, whose pulp seems formed of the placentas. The edible portion of most of these fruits consist of the pericarp, which is formed of three layers; the external, the epicarp, corresponding to the lower epidermis of the leaf and forming the skin to certain fruits; the middle, the mesocarp, representing the parenchyma of the leaf, and forming the pulpy portion of the apple, cherry, date, pear, etc.; and the internal, or endocarp, equivalent to the upper epidermis of the leaf, or the epithelium of the ovary,* and originating the edible portion of the orange and the banana. Yet if morphologically allied to the leaf, it has this important distinction,—the true leaf works for the plant; the fruit coverings of the seed work for themselves primarily, using the produce of the labor of the plant. Without the fruit the plant has a better growth as a plant, as is to be observed in numerous instances. Without the

* Balfour, Bot., 262.

great development of the fruit (Cultural fruit, I mean) the seeds are better nourished, as our examples of seedless fruits show, and also the fact that the wild species which have, so to speak, to look out for their own perpetuation, bear inferior fruits in size and flavor to those improved varieties we have released from the care of self-preservation.

Upon this view of the fruit, we can understand why we can so readily influence the character and the amount of the pulp of the fruit, as apart from the seed. The leaf builds up the plant; the fruit is royal; it uses the supplies furnished by the root and the leaf, and builds up itself. The root and the leaf are providers, the fruit is the regal consumer that adorns and expends through a more or less educated civilization. We can hence influence the fruit through an action on the providers, or we can increase the ambition of the user, or we can exercise our art upon root, leaf, and fruit. The first idea implies the furnishing of abundant fertility to the soil, and favoring culture and climatic conditions: the second idea implies the exercise of the art of selection: the third conveys the idea of intelligent domestication.

The rapid growing and sensitive condition of the parts concerned in the formation of the fruit, render it peculiarly subject to the sexual condition of the plant. An influence of the fertilization of the pistil, which is plainly recognized and quickly noted in the pistil, is not as readily apprehended upon the plant; yet, in some instances, and possibly, in very many, the influence of the pollen is noticed in a change of growth of the plant, as is also the influence of castration or the removal of the seed elements from influencing. This influence, which I have never seen noticed by authors, I am certain I have seen, but the results are too obscure to admit of detailed description, although in some cases plainly evident. They are best seen, and always seen, so far as I have examined, on rapid growing plants. As the pollination then has a strong influence, not only, as is well known, upon the formation of the seed, but also upon the seed coverings, and, as I have hinted, upon the plant considered as a whole, it is well to consider rather in detail, its influence upon the fruit.

Pollination is not fertilization, as the latter process consists of the union of the pollen material with the ovule; the former implies only the reception of the pollen by the stigma of the angiospermous plants. Pollination is not always productive of fertility, nor, on the

other hand, is sterility dependent upon the withholding of pollination or fertilization. Pollination acts upon the seed envelopes; fertilization may act upon the seed-envelopes, but does act upon the ovule. Fertilization is hence a sequence to pollination. Through the changes induced by the process of conscious, or unconscious domestication, we seem able to cause the pollination factor of the anther-product, to act in excess over the fertilizing factor, and hence produce results favorable to edible matter, and less favorable for the seed than would occur under wild conditions.

1. Pollination is not always productive of fertility. Gärtner* has shown by gradually increasing the number of pollen-grains until he succeeded in fertilizing a *Malva*, that many grains are expended in the development, or, as he expresses it, in the satiation of the pistil and ovarium. Again, when one plant is fertilized by a widely distinct species, it often happens that the ovarium is fully and quickly developed without any seeds being formed, or the coats of the seeds are developed without an embryo being produced within. Dr. Hildebrand† has shown that with several Orchidaceæ, the action of the plant's own pollen is necessary for the development of the ovarium, and that this development takes place not only long before the pollen tubes have reached the ovules, but even before the placentæ and ovules have been formed. Darwin‡ sums up by stating "we may admit that in most cases the swelling of the ovarium, . . . is at least aided, if not wholly caused, by the direct action of the pollen, independently of the intervention of the fertilized germ."

2. The access of pollen is not always necessary for fertility. Quatrefages§ says it is now unquestionable that certain plants can produce fertile seeds, although the flower has not been submitted to the action of pollen. Thus Spallanzani, Bernhardi, and Ch. Naudin affirm that female hemp can fructify without the participation of the male. Fresenius‖ says *Datisca cannabina*, female, fructifies very well without the concurrence of the male. M.

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* Beiträge zur Kenntniss du Befruchtung, 1844, 347–351, quoted by Darwin, An. and Pl. I, 483.

† Botanische Zeitung, No. 44, et. seq., Oct. 30, 1863; and 1865, s. 249, quoted by Darwin, ib.

‡ An. and Pl., I, 484.

§ Metamorphoses of Man, etc., Lond., 1864, 271.

‖ Linnæa, 1839.

Tenore* says the same for *Pistacia Narbonensis*, and Ch. Naudin for *Bryonia dioica*.† The same fact is also claimed to have been observed in *Cœlebogyne ilicifolia*, and a species of *Mercurialis*.‡

3. Nor is fertilization always necessary for fruiting. Thus Prof. Treviranus§ says "the circumstance which occurs in some plants (I will adduce only the banana and pineapple among Monocotyledons, and the hop and mulberry among Dicotyledons) that a perfect development of fruit, though with barren seeds, will take place without the process of fertilization, while in most others, under similar circumstances, no fruit is produced." Darwin‖ says "Again, it is well known that with many plants the ovarium may be fully developed, though pollen be wholly excluded, and . . . Mr. Smith . . . . . (as I hear through Dr. Hooker) observed the singular fact with an orchid, the *Bonatea speciosa*, the development of the ovarium could be effected by mechanical irritation of the stigma." Other illustrations may be selected from the statements given in our list of seedless fruits.

We are now prepared to discuss the causes productive of seedless fruits. We first note that (with the exception of the barberry, beech, chestnut, and opuntia) all of our list includes cultivated plants; second, that the majority have been cultivated from a remote antiquity; third, that all but one (and perhaps that) have furnished many varieties; fourth, that seedlessness has been an observed and desirable feature for most of them; fifth, that all can be readily propagated in other ways than from seed; sixth, that in no one instance is seedlessness always present; seventh, that improvement in quality is too often stated or inferred, to be considered accidental; eighth, that prolificacy in fruit is not incompatible with sterility in seed; ninth, that there is a tendency to decrease in size with seedlessness in some cases, and increase in others, and that probably those fruits whose edible portions are formed of placentas come in the first class, and the multiple fruits, and those whose pulp is the mesocarp in the second class; tenth, that the species are about equally divided between northern and southern climates.

We are next to note that neither pollination nor fertilization is

* Ann. des. Sc. Nat., 4th ser., I, 328.
† Hooker's Journ. of Bot., IX., 53.
‡ A. A. Black, Treas. of Bot., I, 309.
§ Jour. Lond. Hort. Soc., 1854, 112.
‖ An. and Pl. I, 483.

always essential to the formation of fruit; that the pollen may influence a development with sterility; that there is an antagonism of growth apparent between foliage and fruitfulness, and between pulp increase and seed maturation, and that cultivated plants are invariably and rigidly subject to the law of selection.

We are also to note that man usually works, even if unconsciously, upon the average, in the direction of his interests, or his satisfaction, and when a diminution in the size of seeds, and improved availability for use, once acquires recognition, there is a beginning of conscious selection.

It has often occurred to me that the influence of high culture upon the amelioration of fruits has been misunderstood. The effect of manuring is to cause increased growth of foliage and shoots, and it is often detrimental to the fruiting, as I have observed in my study upon the maize plant. The influence of cultivation is to check the growth of foliage and increase the fruiting tendencies of the maize plant upon over-rich soil. The effect of pruning, judiciously performed, is to improve the quality of fruit. In order, then, to ameliorate a wild species of fruit, one effort should be to stimulate the growth of the plant to the utmost, by furnishing favorable conditions of soil and fertility, and then to check rampant growth through the process of cultivation, and the art of pruning. In this way, for fruits formed of the mesocarp, we should expect to augment the tendency to increase of pulp, and a variation once obtained might be hoped to be perpetuated and increased through the process of seeding and continuous selection. As the pulp is improved, there is a dimunition in the relative size of the seed for the species, and the seed, as we have indicated in our list, has a tendency to become abortive.

It is quite probable that the continued amelioration of the pulp, which must occur sometimes amongst the vicissitudes of extended and long continued cultivation, is one important factor in the accounting for the seedlessness of some fruits, whether as a direct or more remote cause; especially of those fruits formed of the carpels.

In the multiple fruits, such as the breadfruit and the pineapple, we can understand how cultivation could produce a variation which would be recognized even by the savage, as desirable. Any cause which would diminish the energy of the pollen so that it would imperfectly fertilize, and be expended upon the ovaries without affect-

ing the ovule, and we have many instances of such a condition happening in cultivated plants (the apple of St. Valery, for one instance, and generally observed in hybridizing), and the softening of the core of these fruits, would probably be observed, for the general effect of seed-bearing is to harden the stalk, as for instance, the soft and flimsy cob of the unfertilized grain ear, and the hard, woody cob of the developed grain ear of the maize plant.

Hybridizing may be assigned as another cause whereby, although mules are oftener produced, an occasional seed may be found, and this seed, growing, might produce a seedless plant, which could be perpetuated and multiplied by offshoots, cuttings or grafts. Some of the statements given in our list would bear out this hypothesis.

Development without fecundation may also be assigned as an immediate cause, and this explanation derives additional force from the fact that the male element is apparently much oftener affected by changed conditions, at least in a visible manner, than the female element or ovule.* There would hence, under conditions of the cultivation of the fruit species named, be a tendency towards pollination in excess over fertilization, and selection would here come into play to intensify the differences once obtained, originating from this source. It is easy to believe, through the evidence given by the results of hybridism, that pollen may become unfitted to fertilize, and yet retain an influence upon the seed envelopes, the pericarp, and its modifications. This indeed, we believe to offer a sufficient explanation of the occurrence of many of our seedless fruits.

The influence of irritation in producing a development of the ovarium has been adverted to in the case of the orchid, *Bonatea speciosa*. Other instances can be given where the puncture of an insect produces the structure called galls. Thus, in Framingham, the common blueberry, *Vaccinium Pennsylvanicum*, Lam., occasionally bears a white fruit an inch or less in diameter, resembling a bladder with a fleshy rind, and tasteless; and the same form, but of irregular shape, is to be found in the place of the flowers and leaves, but I have never found any trace of insects within. In Zante, the apples or tumors of the sage, the effect of puncture of a species of cynips, are said by Sibthorp to be made into a conserve with honey. Galls are found on leaves, flowers, fruits, buds, and young bark, says Thomé, and they afford a striking illustra-

* Darwin, An. and Pl., II, 325.

tion of the influence of irritation upon structure. Placing a drop of oil in the eye of the fig, says Downing, causes the fruit to ripen much more certainly, and to swell to a larger size, and although oil can scarcely be considered an irritant substance, yet it seems to act such a part in this case. Whether this has any influence or not on the question of seedlessness, is worthy of future examination, but as yet, so far as we know, it must be considered only as a suggestion. As cucumbers are frequently seedless under glass culture, and as I have never seen them seedless under open-air culture, it is possible that exposure to the sun in the glass house has something to do with the development of the ovarium.

With this presentation we bring our paper to a close, not claiming as yet to have solved the problem, but desiring to call attention to the horticultural importance of this subject. It seems probable that in the future the most rapid horticultural advance is to be sought through the selection of seedlings from fruit containing the fewest and smallest seed of their kind, as unconsciously seems already to have been done in the improvement of the grape. Since writing this paper, I have collected a number of facts which lend publicity to this view.

Note.

The following quotations of additional seedless fruits were obtained too late for insertion in their proper places.

Lucuma *bifera*, Mol., of Chili, bears fruit twice a year. The one set, early in summer, has no kernels; the other set in autumn has two kernels.—*Molina, Hist. of Chili, I*, 129.

The Otaheite Apple, *Spondias dulcis*, which contains a hard capsule, commonly has no seeds in the loculaments or divisions.—*Foster's Obs.*, 179. Firminger was told that the seeds never germinate, but the varieties are propagated by grafting.

Lemon Citron.—The variety known as "Poncire" is always seedless. The Chinese Citron, the "Cedrat," of Florence, is sterile, or nearly so. The Large Orange Citron never contains seed.—*Gallesio, Treatise on the Citrus Family.*

The Lemon.—In South Africa, Thunberg (*Travels, II*, 141) met with a lemon which contained another within it, furnished with a

red rind. Neither of these two lemons had any seed. The Double Flowered lemon, says Gallesio, has no seeds. Other lemons sometimes contain no seeds. The Lime of Naples, the smallest of European lemons, is round, smooth, and very thin skinned, the skin odorous, the pulp abundant, its juice acid and agreeable because of its delicacy and aroma. This is one of the most highly esteemed lemons, adds Gallesio, and has no seeds.

PUMPKIN.—When the *Cucurbita maxima*, *C. pepo*, and *C. moschata* were crossed, they yielded no seed, or only sterile seed.—*Darwin, An. and Pl., I*, 430.

PIRUS LANUGINOSA, DC., or Woolly-Leaved Service tree.—The flowers and fruit resemble those of the mountain ash, but are smaller; the flowers are frequently abortive, and the fruit, when it is produced, is generally without seeds.—*Loudon, Arb. II*, 924.

TOMATO.—There is a seedless variety, fruits almost rose red, smooth and handsome, with few seeds. Very similar to, if not identical with, the "Perfected."—*Burr's Gard. Veg.*, 248.

DATE OF FLOWERING OF TREES AND SHRUBS, IN EASTERN MASSACHUSETTS, 1880.

BY JOHN ROBINSON, PROFESSOR OF BOTANY AND VEGETABLE PHYSIOLOGY TO THE SOCIETY, SALEM, MASS.

The following record of the time of flowering and fruiting of hardy, native and introduced trees and shrubs in the vicinity of Boston, Massachusetts, has been made chiefly at the Arnold Arboretum, West Roxbury; the Botanic Garden, Cambridge, and from trees and shrubs growing naturally in Essex County, during the year 1880. Unless otherwise mentioned the time of flowering is intended.

A few warm days in January sufficed to develop the flowers on the Red and White Maples; and the catkins on some of the Alders, Willows, and Poplars were quite conspicuous; but the season of