THE POSSIBLE ORIGIN OF CUCUMIS ANGURIA L.

by

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Cucumis anguria L., the "West India Gherkin" or "Bur Gherkin", is a cultigen known to have occurred in the West Indies in a cultivated or more or less adventitious state since before 1650 when the first accounts of this plant were published (1, 2). The occurrence of a single species of this old world genus — which is mainly African but extends through South West Asia to India — in America, combined with the fact that it is almost exclusively found in cultivation or as an escape, makes one feel suspicious about its being truly indigenous in the New World.

Naudin (4) discussed the history of this plant and suggested that it was originally introduced from West Africa whence negro slaves were brought to the New World. However, he admittedly did not know any wild African species of *Cucumis* which resembles *C. anguria* sufficiently to deserve consideration as its probable ancestor.

J. D. Hooker (5) also discussed the origin of the West Indian plant and was inclined to agree that it originated from some wild African ancestral form which had possibly changed so much through cultivation that it would be somewhat difficult to recognise the original wild species. He suggested a relationship with *Cucumis prophetarum* and "*C. figarei*" but he cautiously stated that these two species are perennial, whereas *C. anguria* is a typical annual.

A. de Candolle (6) pointed out that although *C. anguria* was generally assumed to be a native of the Antilles, more particularly of Jamaica, two facts plead against this idea. In the first place one of the names of the plant used by the West Indian descendants of negroes is "concombre marron" and the word "marron" in this connection must be interpreted as meaning "run wild", which points to an introduced plant or a cultigen. The second argument used by De Candolle is that *Cucumis anguria* is found only in those areas where slave-trade took place and not in other parts of America with a similar climate (such as the Pacific coast). If the plant which has now such a wide distribution — from the southern United States to southern Brazil — had been present before the discovery of the New World by Columbus, why does it not occur more inland nor on the Pacific coast? The distinguished Swiss botanist finally left the question undecided.

No recent publication throwing light on the problem could be traced.

The account by Harms in "Das Pflanzenreich" (7) is merely a summary of previous opinions.

If one agrees that an African origin is likely, one should be able to indicate the wild parent species. Through my taxonomic studies of the African Cucurbitaceae I am fairly well acquainted with the various species of Cucumus native to this continent. Only one appeared to be a likely candidate, because its morphological characters most resemble those of *C. anguria* — it also has dissected leaves, the same type of pubescence, long fruiting peduncles and soft spines on the fruit, apart from being an annual. This wild plant has been confused by botanists with other species and appears in several floras and monographs as "*C. ficifolius*" or "*C. figarei*", although it was properly described by Hooker in 1871 under the name *Cucumis longipes*. It occurs in West Tropical Africa but extends to South West Africa, Zululand and Nyasaland.

Several strains of this wild species have been in cultivation at the Horticultural Research Station, Roodeplaat (Pretoria) for some time and some of the extreme forms differ more in the degree of dissection of the leaves, in the size of the fruits, and in the development of the soft spines on the fruit, than any of them differs from *C. anguria*. Another striking similarity between the wild plant and *C. anguria* is in the way these plants develop: the young plants first produce a single erect stem which does not produce flowers as a rule and usually does not grow higher than about 20 cm, which is soon followed by a number of prostrate stems branching off near its base and ultimately attaining a length of 1—2 m. The only constant morphological difference noticed between the available material of *Cucumis anguria* and the wild species is that the fruits of *C. anguria* are more oblong in shape as against ellipsoid in the wild form. In addition the soft spines of the fruit are sparser and shorter in *C. anguria* than in most specimens of the wild species. The figures 1 and 2 illustrate these differences.

Another interesting similarity between the two forms is the observation that all the strains of *C. anguria* and of *C. longipes* grown at Roodeplaat show a very high resistance against fungus diseases (such as "arthracnosis") and that their fruits are hardly ever parasitized by the larvae of Trypetid flies. In these respects they are, among the numerous species and varieties of Cucurbitaceae cultivated at Roodeplaat, only equalled or surpassed by Lagenaria. As, at Roodeplaat, the infestation of Cucurbitaceae with both fungus diseases and Trypetids is usually very severe, especially later in the season, the high resistance shown by *C. anguria* and *C. longipes* cannot be incidental, but must be characteristic of both forms, which again emphasizes their close relationship.

Upon my request, Dr S. Rehm of the Division of Horticulture, Pretoria, made artificial cross-pollinations between two strains of the wild species and two different strains of *C. anguria*. Experiments carried out by Naudin about a hundred years ago, which have been repeated several times since, indicate that interspecific hybrids between different species of Cucumis are not easily produced. If an F_1-generation is obtained at all, the fruits produced rarely contain viable seeds. There are some exceptions: the morphologically and biochemically very closely related *C. myriocarpus* Naud.

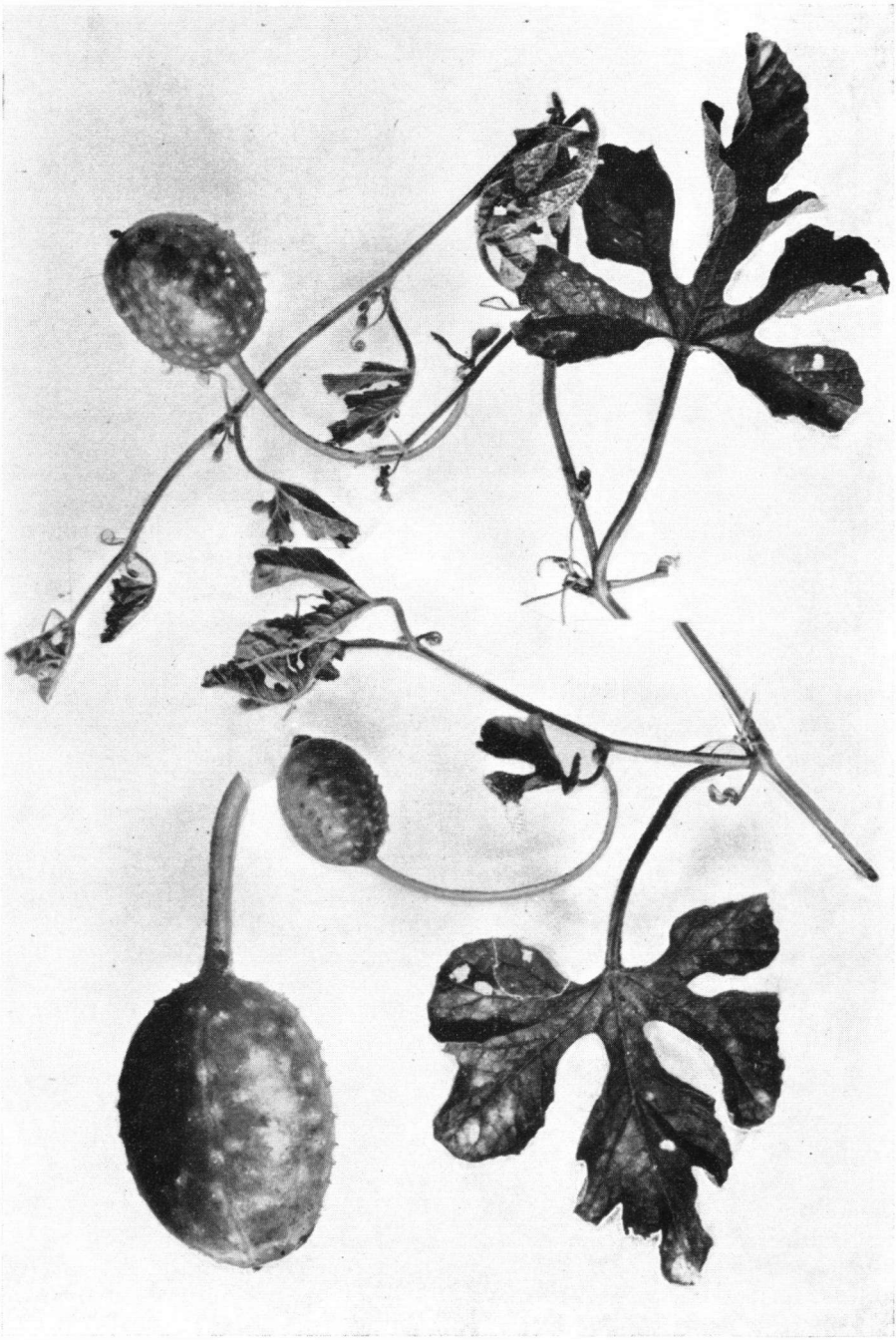


Fig. 1. *Cucumis anguria var. anguria*, two pieces of stem, × ½ and a fruit, life-size (plants grown from seed, received from the U. S. A., at Roodenplaat Horticultural Experiment Station near Pretoria).

and *C. leptodermis* Schweik. hybridize quite easily, but there are reasons to doubt whether these two are worthy of more than subspecific rank and should not rather be treated as subspecies or varieties of *C. myriocarpus*. Similarly the morphologically closely related species *C. angolensis* Hook f. ex Cogn. and *C. dinteri* Cogn. can be crossed. Experience has taught us that, owing to imperfect technical manipulations (such as the tying-up of the corolla of the female flowers before and after the application of the pollen), artificial pollination of cucurbitaceous flowers usually produces fruits from only about 80 to 90 per cent of the pollinated flowers even if pollen of the *same* species is used. If, therefore, cross-pollination between two taxa in the genus Cucumis produces well-developed fruits from nearly all the pollinated female flowers and, in addition, the fruits contain viable seeds, one may safely conclude that these two taxa must be very closely related.

The cross-pollination between the two strains of the wild *C. longipes* and the two strains of *C. anguria* as well as the reciprocal ones, produced well-developed fruits in practically all instances. The seeds taken from these fruits were normally developed and, when kept on wet filter paper in a petri dish at 27° C, germinated in a few days, producing perfectly normal healthy seedlings. The germination was nearly 100 per cent.

From these seedlings plants were raised which were healthy and bore fruit profusely, both after natural and artificial pollination. These F_1 plants were either more or less intermediate between the parent plants, or tended to resemble the parental strain of *C. longipes*, depending on the strain of *C. longipes* used (see figs. 3 and 4). After artificial pollination F_2 seeds were obtained which again were well-developed and germinated well. The season being well advanced, so far only a few F_2 plants have been raised, which appear to segregate into more than one form. These experiments will be continued by Dr. Rehm and we hope that the results will be published *in extenso* elsewhere. However, from these preliminary results, obtained with two botanical taxa in Cucumis which had been geographically separated for over 300 years, one can already safely conclude that these two plants are not only very closely related, but in fact represent a wild form (*C. longipes*) and its corresponding cultigen (*C. anguria*). In this connection it should be mentioned that the strains of *C. longipes* used and, in fact, all samples of this form that have been tested by Dr. Rehm and myself produce bitter fruits. However, the fruits of the wild ancestral forms of several cultigens belonging to the same family, such as *Cucumis sativus* L. (cucumber), *Colocynthis citrullus* (L.) Mill. (= *Citrullus vulgaris* Schrad., water melon), *Lagenaria siceraria* (Mol.) Rusby (calabash, etc.), *Cucurbita spec.* (pumkins, squashes and gourds) are sometimes bitter or are invariably bitter. The cultivated edible forms are apparently mutants in which the gene responsible for bitterness is completely suppressed. There are some reports in the literature referring to *C. longipes* (and to *C. figarei* or *C. ficifolius*, but these names may actually have been applied to specimens of *C. longipes*) as having edible fruits. Several collectors made field notes in which the fruits of specimens obviously belonging to *C. longipes* were said to be edible. As has been demonstrated by Dr. Rehm (unpublished) the gene producing bitterness is dominant, so that the incidence of individuals with edible (i. e. non-bitter) fruits in a natural population can be expected

to be small, or one can expect small localised populations of the non-bitter edible form. On the other hand, individuals of a population with edible fruits, if self-pollinated, produce progeny with edible fruits, because they must be homozygous for the condition "not bitter". This is illustrated by the species *Cucumis hookeri* Naud., of which in certain areas populations with bitter fruits and in other regions populations with edible fruits occur. The fact that so far only bitter-fruited populations of *C. longipes* have been found in Southern Africa does not preclude the occurrence of populations with edible fruits in other parts of Africa, and as was mentioned above, there are indeed reports (how reliable is another matter) of *C. longipes* with edible fruits.

The bitterness in the fruits of Cucumis species being, generally speaking, caused by the presence of a single dominant gene, the F_2 generation of a cross between bitter and non-bitter plants segregates in the usual 3 : 1 relation (three bitter to one non-bitter). The F_2 generation of the *anguria* × *longipes* hybrid, accordingly, can be expected to contain (roughly) one in four which has edible fruits. The few plants raised indicate that this is indeed the case.

The question can be raised if *C. anguria* and *C. longipes* are conspecific or not. In my opinion they must be conspecific because they do not differ more than, for instance, the wild watermelon or "Tsamma" and the cultivated varieties of water-melon. The wild form (*Cucumis longipes*) can be retained as a variety for convenience:

Cucumis anguria L., Spec. Pl. ed. 1, 1011, 1753.

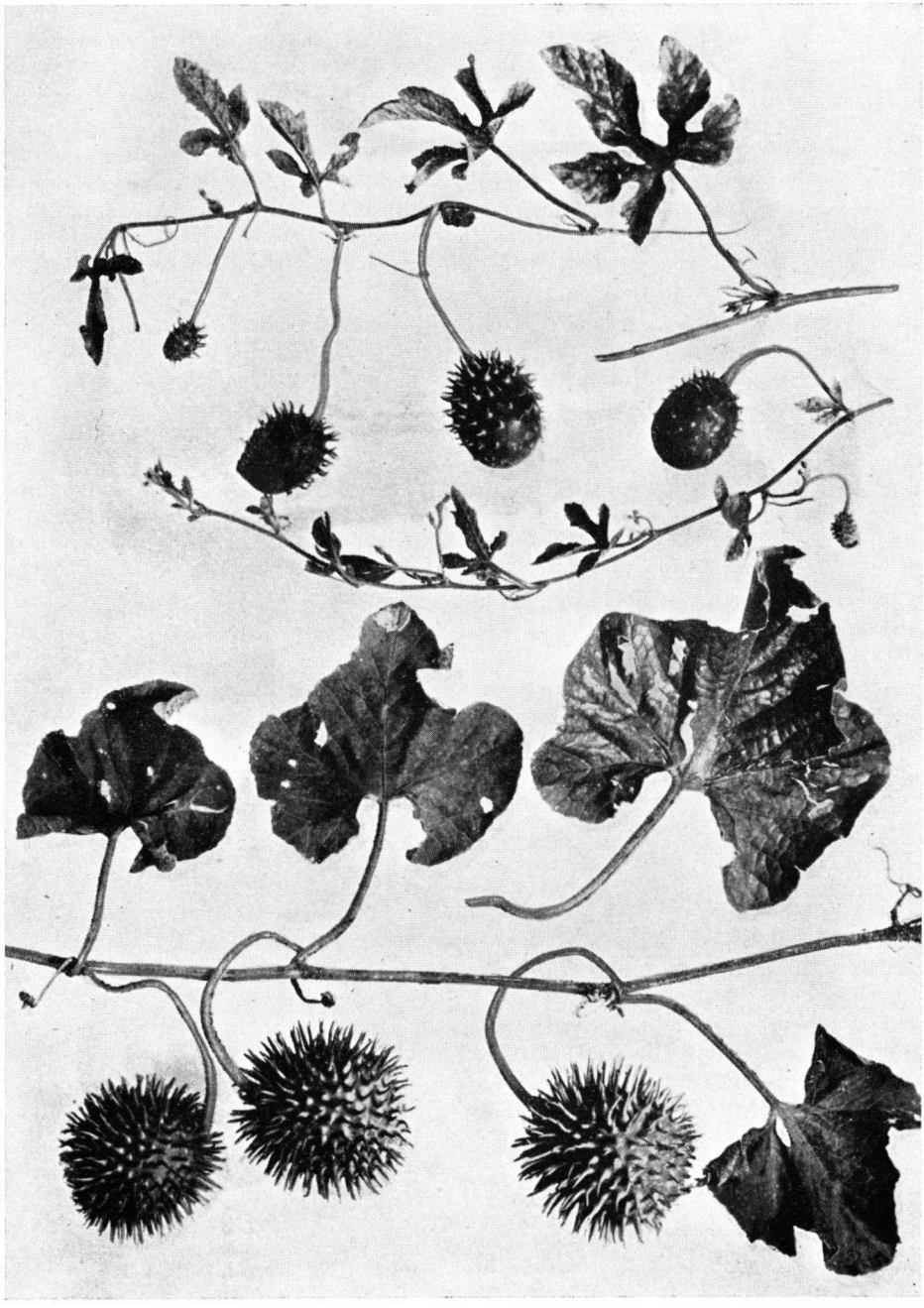
var. **anguria**

var. **longipes** (Hook. f.) A. Meeuse, stat. nov. — *C. longipes* Hook. f. in Oliv., Fl. Trop. Afr. 2, 547, 1871 — *C. ficifolius* Auct. (pro parte), non A. Rich. — *C. figarei* Del. ex Naud. in Ann. Sci. Nat., 4me sér., 11, 16, 1859, pro parte, typo excl.

Wild ancestor of *C. anguria* var. *anguria*, West and South tropical Africa.

If we now return to the possible introduction of the West India Gherkin from West Africa, the suggestion by Naudin and Hooker that the slave trade was responsible seems to be quite acceptable as seen in the light of the experiments mentioned above. The slight morphological differences, such as the less spiny and more oblong fruits of *C. anguria* as compared with those of *C. longipes*, can easily be explained by a process of selection; one would for instance prefer less spiny fruits for pickling and select the least spiny specimens for propagation. However, another aspect must be considered. There are no records of *C. longipes* ever having been cultivated

Fig. 2. Two strains of *Cucumis anguria var. longipes;* top: strain "Clarke 156" from Northern Rhodesia, bottom: strain "Gatooma 26" from Gatooma, Southern Rhodesia, × ½ (both grown at Roodeplaat). The strain "Clarke 156" has leaves which are rather typical of the variety, but the fruits are unusual, because they are small and the soft spines are short and sparse. The strain "Gatooma 26" is quite typical of the variety as far as the fruits are concerned, but the leaves are unusual, because they are only shallowly lobed. These examples show the extreme variability of the variety (compare Fig. 1 and Fig. 3).



in West Africa, nor anywhere else in Africa. Various hypotheses could be put forward to explain this fact such as loss of the original cultivated strains with edible fruits through "contamination" with pollen from the form with bitter fruits resulting in an impure, predominantly bitter-fruited progeny, so that the cultivation was discontinued, whereas only the homozygous edible form was introduced into the West Indies and remained "pure" (i. e. homozygous non-bitter). An alternative possibility is the simple assumption that the species was never in cultivation in West Africa at all, but was simply gathered by the natives from wild plants growing near their settlements. As early as 1761 Adanson, in his treatise of the Baobab (3), discussed the possibility of introduction of African plants having taken place through the slave trade, followed by rapid naturalisation so that several plants are now seemingly indigenous in the New World which might actually be African in their origin, and he issued a warning not to jump to conclusions without taking other factors into account such as phytogeography. He also mentions that negro slaves arriving in the New World had bags or pouches in which they carried tobacco and provisions including the seeds of useful plants. When these natives were captured by slave-traders they would probably not voluntarily have parted with these bags, certainly not with an uncertain future or destination. The fruits of *C. longipes* keep for a few weeks if the conditions are not too unfavourable, but in any case the seeds retain their viability for years as long as they are kept dry and they could certainly have survived the crossing of the Atlantic, even in the sailing ships and at the average rate of travel of the early discovery age. As pure chance may play an important part in such cases of plant introduction it seems unnecessary to assume the repeated introduction of *C. longipes* into America. It need have happened only once and it is, therefore, not even necessary to assume that *C. longipes* fruits were a very common or a regular article of food among the natives of West Africa. They were, perhaps, rather only occasionally used (for instance "when in season" or when other food was scarce) and, therefore not frequently carried in the natives' pouches.

The seeds may have been deliberately planted in the West Indies when first introduced or they may have been discarded and started growing in a semi-wild state, but this is rather irrelevant and can never be ascertained anyway.

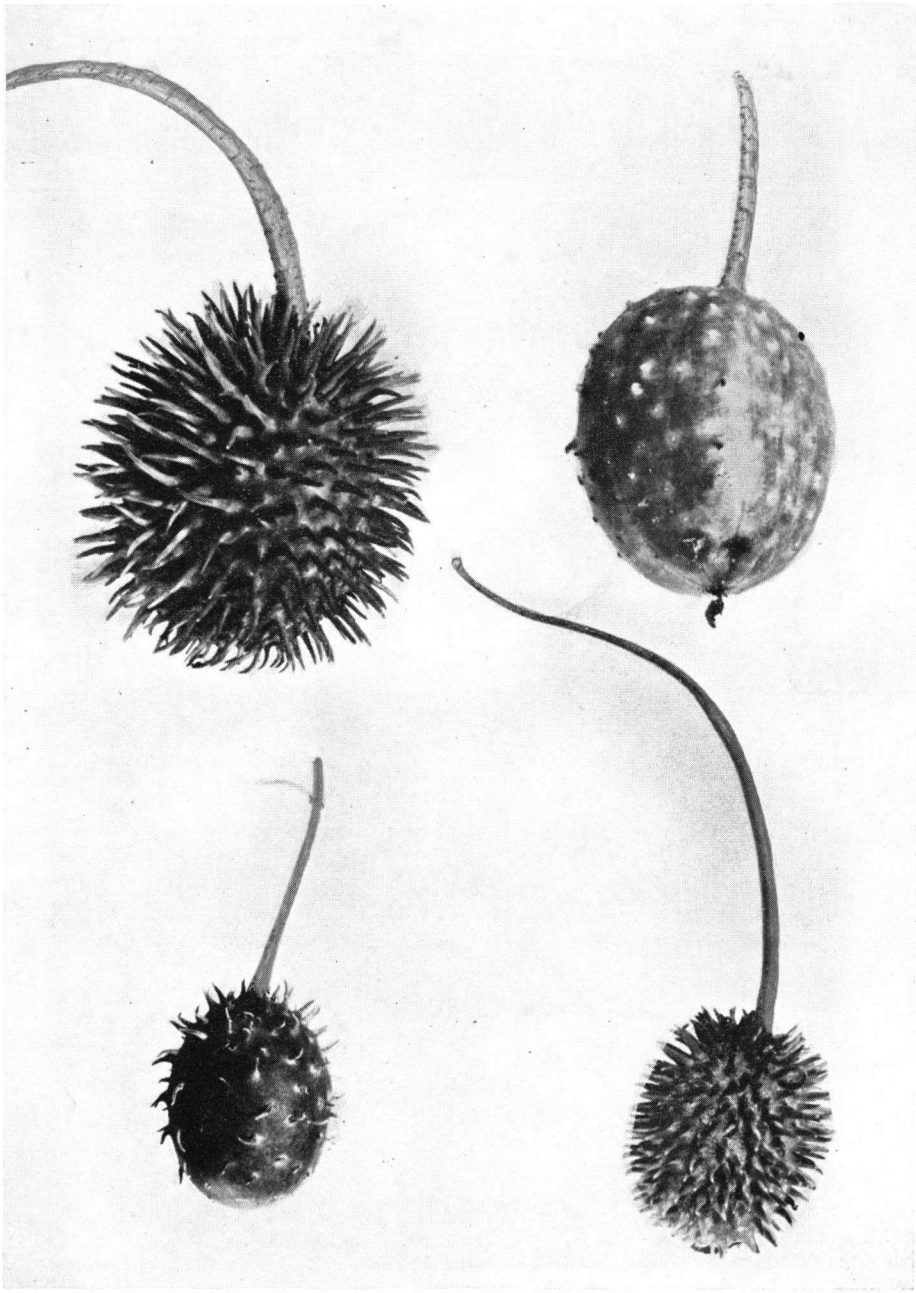
Summarising, the following conclusions appear to be justified:

1. The West India or Bur Gherkin, *Cucumis anguria* L., is a cultigen descended from a non-bitter variant (mutant) of an African wild species described as *Cucumis longipes* Hook f., which has normally bitter fruits.

2. The original stock reached the New World over 300 years ago,

Fig. 3. Fruits of *Cucumis anguria var. longipes* strain "Gatooma 26" (top left), *C. anguria var. longipes* strain "Clarke 156" (bottom left), *Cucumis anguria var. anguria* (top right) and a hybrid *C. anguria var. anguria* × strain "Gatooma 26" (bottom right). All fruits life-size, except that of the hybrid, which is × 0.6.

N.B. The fruit of the hybrid *C. anguria var. anguria* × strain "Clarke 156" is very similar to that of "Clarke 156" and was not separately figured (see fig. 4).



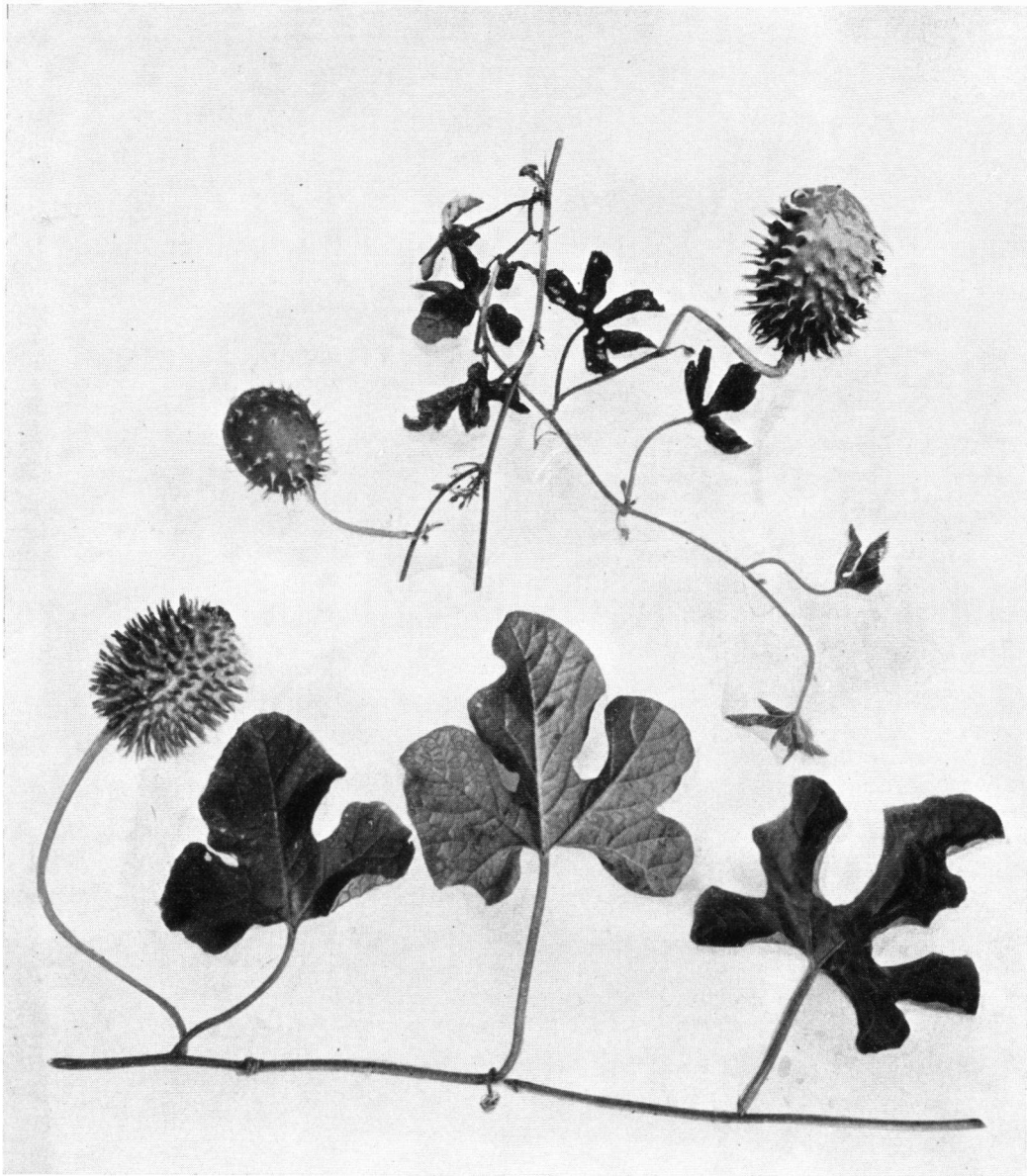


Fig. 4. Hybrids of *C. anguria var. anguria* (♀) and *C. anguria var. longipes* (♂), F_1-generation, × ½. Top: hybrid with strain "Clarke 156", plant very similar to wild form, but mature fruit larger and more oblong; bottom: hybrid with strain "Gatooma 26", plant intermediate between parents in leaf-shape (blades deeply lobed) and fruit morphology (soft spines shorter, sparser and more rigid than in "Gatooma 26"). Compare with fig. 1 and fig. 2. Specimens grown at Roodeplaat.

most probably through the early slave trade between West Africa and the West Indies, the actual introduction being more or less accidental.

3. The slight morphological difference between the cultivated *C. anguria* and its ancestral form *C. longipes* can easily be explained by a combination of its isolation and a certain amount of selection by man during a period of about 300 years.

Additional Note

In May, 1958, more results became available from the F_2-generation and from the back-crosses of the F_1-generation with the non-bitter parent. As is to be expected in the case of a single dominant factor causing bitterness, in the first case the relation of the numbers of plants with bitter fruits to those with non-bitter fruits is 3 to 1, in the second case 1 to 1. However, the F_2-generation varies considerably in other respects, such as the development of the spines (long or short, coarse or fine, conspicuous or reduced), number of spines, shape and size of the fruit, lobing of the leaves and width of the lobes of the leaves. Apparently these characters vary quite independently from the factor causing bitterness and it is thought that by crossing cultivated strains of *Cucumis anguria* with bitter wild strains the whole "gene reservoir" of the variable wild species could be introduced into the cultivated non-bitter form in view of improving the West India Gherkin. In several respects the strains of *C. anguria* are superior to the gherkin varieties of *C. sativus* as a crop. The production of fruits in *C. anguria* is enormous in a slightly shorter growing period, *C. anguria* is far less suspectible to fungus diseases and eelworm (Nematodes) than *C. sativus* and the fruits are (in Pretoria at least) hardly ever parasitized by the larvae of Trypetid flies which attack *C. sativus* rather badly. Improved varieties of *C. anguria* which can compete with gherkins as far as suitability for pickling is concerned would be a much more reliable and more profitable crop than the gherkin varieties of *C. sativus*. The breeding work would be facilitated by the fact that all bitter progeny can be discarded at once, only the non-bitter forms (homozygous for this factor) being retained.

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