CONSIDERATIONS ON THE AFRICAN ORIGIN OF *ELEUSINE CORACANA* (L.) GAERTN.

K. L. MEHRA*
Royal Botanical Gardens, Kew, Richmond, Surrey, U.K.

THE agricultural connections between India and Africa are so obvious that numerous authors[1-3] have referred to them. It is reasonably certain that a number of cultivated plants in Africa have come from India, but most of these introductions have probably been within the Christian era. Recently, however, Anderson[1] has called attention to the fact that there is a possibility of a much earlier movement of primitive agricultural products from Africa through Ethiopia and Yemen and up the seaward edge of the Arabian peninsula and into Southern India. The lack of realisation of an earlier migration of crop plants from Africa to India was perhaps due to the fact that firstly, all such plants bear Sanskrit names; secondly all of them are crops of such minor importance as not to have merited attention had anything as sophisticated as the late Stone Age domesticates been available, and lastly all of them were unknown in ancient Egypt, or appear very late in the record. During the course of the present investigation preliminary experimental evidence has been gathered together to suggest that perhaps the Ragi Millet *Eleusine coracana* (L.) Gaertn. is one of the cultivated plants which migrated at an early date from Africa to India.

De Candolle[4] indicated that *E. coracana* probably originated in India since firstly, the ancient monuments in Egypt bear no trace of its cultivation in the earlier times and secondly the earlier Graeco-Roman authors, who knew that country so well do not speak of this crop. Burkill[5] suggested that *E. coracana* is a cultigen of the wild species *E. indica* (L.) Gaertn., and that its early selection by man appears to have taken place in India since firstly, it has long been cultivated there; secondly it has Sanskrit name, *i.e.*, *Rajika* or Ragi; thirdly it was there probably at the time when the Aryans arrived in India and lastly its decrease in Africa towards the west would also suggest that perhaps it has crossed from east to the west. Also, Werth[6] was of the opinion that *E. coracana* originated in India from where it spread through Arabia, Abyssinia, to the rest of Africa. However, Vavilov[3] proposed that *E. coracana* originated in Abyssinia, while Chandola[7] has expressed the opinion that perhaps the millet originated in India and Africa. Furthermore, it was pointed out[8] that India and Africa have several features in common with respect to the genus *Eleusine* especially the presence of a similar number of dominant genes; similar extent of diversity of species; similar number of wild species and lastly the similar type of cytological behaviour of the materials so far investigated. These facts considered together would, thus, complicate the problem of the migration of *E. coracana* from India to Africa or *vice versa*.

Cytological studies conducted during the course of the present investigation have revealed the presence of a somatic chromosome compliment of $2n = 18$ and 36 for *E. indica* and $2n = 36$ for *E. coracana*. Also, a regular formation of 18 bivalents was observed during meiosis in the microsporocytes in *E. coracana* and in the tetraploid *E. indica*. However, it may be pointed out that the tetraploid taxon of *E. indica* has recently been assigned[9] a separate specific epithet *E. africana* Kennedy O'Bryne on account of this cytological and certain morphological differences from the diploid form. The diploid taxon has, however, been retained within *E. indica*. Regular bivalent formation during meiosis, the presence of duplicate factors and polymeric factors in *E. coracana* would seem to suggest[8] that perhaps it is an allotetraploid.

Morphological analysis[9,10] of Eleusine species has revealed the presence of four distinct taxa, *i.e.*, the wild types (*E. indica*: $2n = 18$ and *E. africana*: $2n = 36$) and cultivated types (*E. coracana*: $2n = 36$; African Highland type and Afro-Asiatic type). Furthermore, comparative taxonomical analysis of *E. indica* and *E. africana* revealed that the differences between these two species are mainly in size and proportions, *i.e.*, in the widths of the rachis and stem and in the lengths of the spikelets, glumes and lemmas. These are the types of differences which one would often expect to find between closely related diploid and tetraploid taxa. Presuming that *E. indica* is perhaps one of the two putative parents of *E. africana*, the taxonomical description of the other putative parent has been worked out[10] and the herbarium material is being studied to find out the taxon with which it shall conform.

Amongst the cultivated types, the African Highland type differs from the Afro-Asiatic

* Present Address: Botanist, Central Potato Research Institute, Simla-1, India.

type because of its longer lemmas, glumes and spikelets. Also, the grains are enclosed inside the glumes in case of the African Highland type, whereas these are exposed in Afro-Asiatic type. Furthermore, the African Highland type resembles *E. africana* because of the presence of long lemmas, glumes and spikelets, whereas on the contrary the Afro-Asiatic type resembles *E. indica* because of its short lemmas, glumes and spikelets. It has, however, been proposed[10] that *E. africana* originated as a result of hybridization between *E. indica* and a closely related taxon followed by chromosome doubling. It may also be pointed out that the morphological differences between African Highland type and *E. africana* are slight and these are shattering and non-shattering spikelets and plump and non-plump grains. One normally expects to find such differences between closely related wild and cultivated taxa. Furthermore, it has been shown[11] that in a farmer's field in Uganda the cultivated and wild types (*E. africana*) cross with each other and produce fertile hybrids. There is, thus, a good reason to believe, therefore, that the cultivated African Highland type might have originated from *E. africana* by selection at an early date for a large grain type. In fact, Anderson[1] frequently saw a semicultivated variety of *E. indica* in Ethiopia, which may as well be *E. africana* or *E. coracana* (African Highland type) or their hybrid derivatives. These semi-cultivated types seem to have been developed for their long wiry culms, which are used in making the expertly fashioned native sieves. The sieve itself is knit from these stems, producing a fine tough sieve of remarkably even mesh. There are no reports of such sieves from other parts of the world and, if these are unique to Africa, then it has been argued[1] that the presence of a specialized use for this grass in Ethiopia and of a domesticated or semi-domesticated robust strain developed there for this purpose increases the likelihood that *E. coracana* originated in Ethiopa, from where it migrated to India during the pre-Aryan times.

During the course of the present investigation more than 200 herbarium specimens of *E. indica* and *E. coracana* collected from India, Pakistan, Nepal and Sikkim have been studied and none of them conform to *E. africana* or *E. coracana* (African Highland type). Most of these plants belong to either *E. indica* ($2n = 18$) or *E. coracana* (Afro-Asiatic type : $2n = 36$). It would seem to suggest that perhaps *E. africana* and the cultivated African Highland type are not present in India. It is proposed that the naked grain Afro-Asiatic type common in India originated from the African Highland type through selection for a small glumed type with exposed grains. Also, the genetic mechanism to produce such a reduction in the size of the glumes has already been suggested.[10,11] In fact, the hybridizing populations[10] of *E. africana* and *E. coracana* (African Highland type) in the farmer's field in Uganda produced amongst their segregates a few plants which resembled the Afro-Asiatic type. The evidence indicated as above seems to suggest that firstly, *E. africana* the progenitor of the African Highland type, originated from *E. indica* through hybridization with a closely related taxon followed by chromosome doubling in Africa and secondly the cultivated Afro-Asiatic type common in India was developed from the African Highland type in Ethiopia.

In conclusion, it can be said that there is good reason to believe that *E. coracana* is African in origin instead of Indian as proposed by earlier workers.[4-6] The present paper is an attempt to further document the possibilities of an earlier migration of crop plants from Africa to India by way of Sabaean Lane on the basis of whatever little the author has been able to present. Nevertheless, it is hoped that such a possibility shall become more convincing when supported with data on other such little known crops from Africa.

The author wishes to express his gratitude to Dr. Edgar Anderson of Missouri Botanical Gardens, Saint Louis, U.S.A., for constant encouragement and interest during the present investigation. Thanks are also due to the Director, Kew Gardens, U.K., for the facilities to work and to the British Council for the grant of a post-doctoral fellowship to study the herbarium material at Kew.

1. Anderson, E., *The Evolution of Domestication in Evolution after Darwin*, Univ. Chicago Press, U.S.A., 1960, **2**, 67.
2. Murdock, G P., *Africa*, McGraw-Hill Book Co., New York, U.S.A , 1959.
3. Vavilov, N. I., *The Origin, Variation, Immunity and Breeding of Cultivated Plants*, The Ronald Press Co., New York, U.S.A., 1951.
4. De Candolle, A., *Origin of Cultivated Plants*, Kegan Paul, Trench & Co., London, 1886.
5. Burkill, I. H., *A Dictionary of Economic Products of the Malay Peninsula*, Crown Agents for the Colonies, London, 1935.
6. Werth, E., *Angew. Bot.*, 1937 **19**, 42.
7. Chandola, R P., "Cytogenetics of millets," *Cytologia*, 1959, **24**, 115.
8. Krishnaswamy, N., "Origin and Distribution of millets," *Indian J. Genet.*, 1951, **11**, 67.
9. Kennedy O'Byrne, J., "Notes on African grasses," *Kew Bull.*, 1957 **11**, 65.
10. Mehra, K. L., "Differentiation of the cultivated and wild *Eleusine* species," *Phyton* (In press), 1963.
11. —, "Natural hybridization between *Eleusine coracana* and *E. africana* in Uganda," *J. Indian bot. Soc.*, 1962, **41**, 530.