2. Maize variation in relation to the natural and cultural environment.

Systematic studies of a maize collection from the Sierra of Peru and analysis of the environment were carried out at Berkeley, California and were summarized by a doctoral dissertation accepted by the University of California in June, 1970. Maize was studied with the aims of describing clusters of types, of defining character axes which reduce the variation to more comprehensive patterns, and of relating the types and character variation to the environment. The natural and cultural environments were described to help explain the maize variation, to provide a means of improving future maize collections, and to summarize those observations that the author made during the study.

Over 900 ears were collected and partially analyzed while with the "Study of Inca Provincial Life" in Huánuco, Peru, from 1964 to 1966. The project was mainly anthropological involving historical, archeological and ethnological work and was directed by Dr. John Murra. The author was responsible for ethnobotanical and ecological studies.

The systematic studies were based on 117 morphological variables and a sample of 65 ears from the collection. Factor analyses of this sample and of the published data of Grobman et al. (1961) gave similar results. Eight major factors have been described, called Ear Diameter and Kernel Length, Rachis Diameter and Thickness, Ear Length and Shape, Shank Diameter, Cupule Length and Shape, Row Number and Kernel Shape, Kernel Denting, and Kernel Hardness. There are several other minor factors. Using all the variables, numerical taxonomy of these ears, with nine additional ears from Mexico, Ecuador and two archeological sites on the South Coast of Peru, has shown that groupings of types are possible, but that many individuals remain intermediate or atypical. Factor analysis allows one to better understand the variables, but does not directly help the systematic work. Reduced sets of variables capable of classifying the material almost as well as the full set are difficult to select.

In order to explain the variation found in Andean maize races, one needs to compare their distribution and systematic descriptions with the environment and history. The thesis of Grobman et al. (1961) that Cuzco maize was spread by the Incas to many parts of their empire, from

Argentina to Ecuador, was found to be strengthened by linguistic evidence that the Cuzco dialect of Quechua shows a very parallel pattern. However, the Huánuco area, in the middle of what once was the Inca empire, has practically no Cuzco maize and a distinct set of Quechua dialects. A theory has been advanced that relates this anomaly to earlier Andean history. As a corollary it is proposed that Cuzco maize derives in part from maize of the Northern Andes, along with many other features of the Incas which were unique in Southern Peru.

Not only does maize relate to cultural history on a broad scale, but locally there are detailed parallels. Ethnic areas in the Huánuco region have been defined using many traits. Ethnographic data were gathered relating to agriculture, settlement pattern and clothing. Linguistic studies further added to the ethnic definitions and aided in comparison with other regions. The areas defined through these studies show very close similarity to tribal areas described at the Spanish Conquest.

Near the city of Huánuco, a people once called the Chupacho, living between 1900 and 3300 meters elevation, have maize more like that of Ecuador than that of people just 40 km up the same valley. On the mountain slopes nearer the continental divide, villages between 3000 and 4000 meters contain people distinct by a great many traits from those of the valley. Their maize is more like southern Peruvian maize than Chupacho maize. The boundary between these two peoples and their maize is exactly where documents of 1549 and 1562 say the tribes then had a boundary. Probably this pattern has been stable for a millenium.

Although the natural environment of Peru has been studied fairly extensively, including vegetational and climatic analyses by myself, there is little one can predict about maize using this knowledge. Even within an ethnic area there seems to be little relationship. McClintock has shown that high altitude maize has few chromosome knobs. Low altitude correlates moderately with larger ears with high glume to kernel and rachilla to kernel ratios, and it correlates poorly with thick shanks, longer cupules, and the "tripsacoid" character complex of Sehgal. However, this information is much less important than data on cultural

patterns and practices for the efficient collection of new maize races and populations and the interpretation of maize evolution.

Robert McK.Bird

3. Multivariate and quantitative studies of maize systematics and genetics.

In conjunction with Drs. S. G. Stephens and M. M. Goodman, several aspects of maize systematics are being investigated. A series of genetic studies is aimed toward understanding the genetic basis of several of the morphological traits used so frequently in determining racial interrelationships. A classification of maize races is being attempted by using different multivariate techniques. Many new morphological characters are being evaluated. Although no method seems to exist for selecting a small set of characters which would classify material almost as well as the full set, it is hoped that eventually there will be a reduction in the number of variables needed. Probably different subsets will be needed for defining maize groups and races within each geographical region and within each major subdivision of the species. A reduced set of variables accounting for most of the variation present in the maize to be studied would greatly aid research into maize evolution by allowing much larger samples to be studied.

Although several hundred maize races and subraces have been described, there has been little success in determining their interrelationships. A study of variables can be more carefully and easily made when the data are obtained from a "balanced" sample of objects, "balanced" in that all the major trends of evolution are sampled. Therefore tentative groupings of races are being described, perhaps 40 for the present species Zea mays. Many races will be unique, intermediate or too variable to be properly ascribed to a group. A more careful grouping of races should be possible when the variables have received more study.

During my doctoral work an attempt was made to use factor analysis for classifying. It was not fully satisfactory, but factor analysis helps greatly in more meaningful selection and characterization of variables.

M. Goodman at this campus is continuing study of principal components of maize, the effects of the environment on variables and