Some Problems in Reef Coral Taxonomy[1]

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This paper is a brief presentation about some of the current problems in reef coral (hermatypic) taxonomy in relation to the role of the taxonomist and how well that role is being fulfilled. In a broad sense, a taxonomist organizes the tremendous diversity of life into an ordered arrangement of related forms. At the first level of organization the life forms are arranged into basic groups, each of which possesses a more or less common set of affinities. At the next level these basic groups are related to other basic groups which together have a broader range of common affinities. This grouping into higher hierarchial organization levels continues until the range of affinities are all encompassing of life itself. Taxonomists work directly in two dimensions of time—the present and the past. They not only organize the living forms, but also those forms which lived in the past by grouping the evidence, which by chance, has been preserved in the crust and sediments of the earth.

In biology the basic functioning unit is the organism, the study of which, progresses in two, but opposite, directions. Toward one end of the spectrum of study biologists are subdividing the fundamental unit into systems, organs, tissues, cells, organelles, and biochemical and molecular constituents to the very threshold of life itself. In an opposite direction biologists study the individual functioning unit or organism, populations, assemblages, and communities. At this end of the spectrum of study interactions of the organism with its environment are as complex as the metabolic pathways are at the opposite end. The historical progression of biology has nearly always started at the logical point of organizing what is present in terms of kinds of organisms and their relationship to each other. It is from this basic starting point that the various interrelated disciplines of biology have developed. The role of the taxonomist in this disciplinary pool is to provide a body of knowledge which gives the determination as well as the basis of that determination for the various organization levels of organisms and the relationships of these levels to each other. As with any scientific discipline, the existence of taxonomy depends not only upon the generation of information but also upon the assimilation of knowledge from other disciplines as well. In recent years the amount of feedback from other disciplines, especially in the form of new taxonomic tools, has been considerable, and in theory much has been incorporated into the body of taxonomic

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knowledge. Because of the traditional emphasis on working with the morphology of the skeleton the coral taxonomist has been somewhat lax in the incorporation of these new tools which have been embodied into the science for some time. It is primarily in the basic first level of organization where coral taxonomy is not fulfilling its role to other scientific disciplines.

In the literature, symposia, and other meetings where scientists communicate their ideas, it is not clear in an increasing number of occurrences when the specific level is used, as to just what coral is being refered to. This uncertainty at the specific level of organization leads to a great amount of confusion. Other work, from which general conclusions can be drawn, becomes obscure and difficult to make when a considerable degree of uncertainity exists at the specific level. Ecological, physiological, and other data are relatively meager for reef-building genera, such as *Acropora, Montipora,* and *Porites.* This is brought about for the most part by the reluctance of workers to study this important group of corals because of the uncertainty of their specific determination. The multiplicity of names in the above three genera is staggering; over 250 in the genus *Acropora* alone (Wells, 1969). Even though the number of valid *Acropora* species is most certainly far less than the above number, there are probably still some undescribed species, especially from deeper water biotopes. A wake of other new species will also undoubtedly follow in other genera as more intensive and complete investigations of the deeper water biotopes are carried out in the Indo-Pacific, similar to the results of such investigations which were carried out in the Atlantic by T. F. Goreau and his co-workers (see Goreau and Wells, 1967).

Looking at the "species problem" in corals from a historical aspect reveals that some of the present difficulties arose, quite naturally, for a number of reasons. As corals first began to appear in limited numbers from widespread collections, it was not too difficult to separate them on rather limited and traditional morphologic grounds. Leading also to the multiplicity of species in the literature was the poor understanding of the plasticity and range of form in corals. Commonly, variation of almost any sort was ascribed to a new species. Also many species were described on the basis of small fragments from which a poor indication of the form or variation of the colony could be inferred. Ecological data, other than depth or broad generalized habitat conditions, were generally lacking for most specimens in a collection. Confusion also arises in determining distribution from references of specimens with no locality data, or if present, by broad geographic regions such as the Pacific, Atlantic, or Indo-Pacific seas. Localities indicated for commercially purchased specimens are frequently erroneous and misleading. Contributing also to the problem was the communication between early workers which was undoubtedly slow and poor, resulting in the descriptions of collections with little knowledge of previous work. As a result of the inadequate information contained in many early descriptions, they are of little help when attempting to identify specimens.

As coral collections became more extensive it was found that many specific characters were overlaping with others. The awareness, that was suspected by some, that reef corals were extremely variable in their range of characters and growth forms, became generally accepted. Some workers even abandoned the binomial concept and named corals on a morphological basis by geographic locality (Bernard, 1905). Other workers expressed the view that apparent diversity of entire groups was just an expression of variation stemming from habitat differences from one part of the reef complex to another. Notable among those with this view was Hickson (1898). Gradually the factors responsible for inducing and controlling variation in corals began to be studied and better understood. Unfortunately, many of the above factors which contributed to the multiplicity of described species in the early literature are still in effect in some of the recent works today.

Briefly some of the factors known to control or induce variation in corals are light, sedimentation, current and water agitation, temperature, depth, salinity, emersion, physical damage, predation, intra- and interspecific competition, association with other organisms, disease, substrate topography, and inherent genetic variation. Some of these factors have a greater degree of influence over the distribution of corals rather than in controlling or inducing variation in their form. Temperature and salinity are probably more important in affecting coral distribution than in form. Depth in itself seems to have little direct influence in the form of corals, but indirectly it controls the degree to which many other ecologic factors are expressed. Sedimentation controls coral distribution to a great extent, but where corals do live in regions of its accumulation, their form tends to be modified somewhat in relation to the kind and rate of settling. Suspended particulate matter in the water column also reduces available light. Currents and water movement in many instances influence the growth form of corals, particularly in the orientation of their branches in relation to current direction. Emersion, particularly by low spring tides, influences coral form in shallow water habitats by limiting upward growth of the colony beyond a certain mean sea level, thus producing flat-topped or microatoll-shaped forms. Mechanical damage caused by the fragmentation of colony parts by waves or water agitation and abrasion by unstable substrates modify form. Predation on corals by other organisms modifies their form by the removal of skeletal parts or polyps. Coral form may be influenced by competition with other organisms or by intra- and interspecific interaction with other corals. Interactions with other organisms can produce growth-promoting or -inhibiting substances which modify coral form. Associations of other organisms with corals modifies or induces changes in skeleton form. As corals increase in size and age, distinct changes usually occur in their form which would otherwise be absent from smaller and younger individuals. A common occurrence of this type is in the secondary deposits of skeletal material which may obsure features which were obvious and typical in younger colonies. Disease can produce pathologic features which are quite different from normal healthy corals. Toxic substances from water pollution can also modify or induce changes in coral form. Substrate topography induces considerable variation in coral form, particularly in encrusting species, where the overall shape is more or less directly related to the underlying configuration. Light is probably the most important ecologic factor influencing hermatypic coral form and distribution. This degree of influence is not surprising, considering the coral-zooxanthellae relationship and the fact that it is also one of the most variable ecologic factors in the coral reef environment. Light intensity and quality, at any one location on the reef surface, is determined by the amount of primary insolation reaching the waters surface, the degree of air-sea interface disturbance, water depth, optical density of the water, amount of particulate substance suspended in the water column, and the reef surface orientation to incident light. The most important aspect about light is the direct relationship between it and the rate of calcification (Goreau, 1959). Calcification rate appears to determine the size and density of coral polyps and branches as well as the overall colony shape and orientation. The presence and intensity of some coral pigments is related to intensity and quality of light.

Now that a considerable number of ecological factors are now known which control or influence form in corals, new information, as acquired, should be added to the present taxonomic literature and be included in future descriptions. Ideally the type of a species should lie at the central point of specific variation and a number of paratypes assigned to show the important aspects of variation on either side of the type. As additional knowledge of variation becomes known the position of the present types can be established within the specific range. All too often the type is inferred to represent the median point in specific variation when in reality it may represent a rather uncommon form which lies at the extreme limit of variation for a particular species.

It appears that one of the primary reasons for the common absence of ecologic variation in coral descriptions lies in the failure of the collector to provide such data with the specimens from which such determinations could be made. One specimen accompanied by adequate ecological data is sometimes more valuable than a suite of a dozen or more specimens lacking such data. Specimens collected for taxonomic use or for determination should ideally be accompanied by the following data. If a large collection is to be made from a fairly large region, some kind of systematic approach should be used. If time permits a reconnaissance survey of the region saves much time and duplication of collection effort. Such a survey should reveal the range of coral biotopes present from which a collection more representative, not only of the region but of specific variation as well, can be planned. Once a collecting site or station has been selected, the biotope should be indicated which places the specimens within a restricted but still somewhat broad ecological setting. Microhabitat data should be recorded next which more sharply defines the limits of various ecological parameters. Microhabitat data for a specimen should include depth, type of substrate, its position in a three-dimensional reef framework, an estimation of substrate coverage by living corals, and the local overall coral diversity. Several relative estimations should be made which include water movement or agitation and currents, light intensity, water turbidity, and rate of sedimentation. Each specimen collected should be accompanied by its diameter, height, growth form and overall shape, and the part of the colony from which it was collected. The above specimen data is automatically collected, and need not be recorded, if the entire colony is sampled. If it is not feasible to collect the entire colony, several sections should be collected which represent the variation within the colony. There is usually a considerable degree of intracolonial variation from the well-lighted dorsal surface of a colony where calicular features are well developed compared to the poorly-lighted basal regions where calicular features are less well developed. Other specimen data should include the apparent color of the colony and the relative abundance of the species within the biotope. A field reference number should be attached to the coral as it is collected. This is easily done by attaching a prenumbered tag (plastic drafting film) to the coral by a rubber band which has been previously looped through a hole in one end. This type of reference tag is unaffected by water and most bleaching compounds and should remain attached to the specimen throughout the cleaning period until a permanent catalog number is given to the specimen.

Recording of the above field data at first may seem to be excessive, difficult, and time consuming, but if the problem of plasticity of coral form is to be undertaken it must be done by collecting field data and not by growing corals under laboratory conditions. Even in laboratories with adequate running sea water systems it is impossible to duplicate and nearly impossible to even approach the actual conditions under which most reef corals live and grow. The recording of underwater data is not nearly so difficult as one might think. Data are easily recorded underwater by writing with a common pencil on thin plastic sheets which are held in place by a small clipboard. A one or two meter long plastic strip marked off in centimeters is adequate for making all the necessary underwater measurements. Nearly all the estimations and relative measurements can be recorded in a scale of ranges represented by letters and numbers. Much of the data can be written in abreviated form to save time. If extensive collecting is to be done, a standard format can be prepared on the underwater sheets before entering the water. A simple estimation of coral cover can be made by counting the number of centimeters of substrate occupied by living coral underlying five to ten serial lengths of the plastic measuring strip. Much information can be recorded underwater by making small drawings particularly in reference to the part of the colony sampled or its position and orientation in reference to light and the three dimensional reef framework. One of the most valuable underwater recording tools is the camera, particularly if it is equipped with a lens which allows both close-up features and views of the entire colony to be photographed. It is a welcome addition to the literature to see an increasing number of *in situ* illustrations of coral colonies which convey much better than words the form of reef corals.

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