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Modern Approaches to the Taxonomy of Red and Brown Algae

edited by

D.E.G. Irvine
and J.H. Price

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MODERN APPROACHES TO THE TAXONOMY OF RED AND BROWN ALGAE

Proceedings of an International Symposium held at the Polytechnic of North London

Edited by
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The red and brown algae – mainly multicellular marine benthic organisms – offer challenging problems to the taxonomist. They are often difficult to study in the laboratory, comparatively simple in structure and often highly 'plastic' in form.

Traditional approaches have been based frequently on the morphology and anatomy of limited numbers of preserved specimens; inadequate or conflicting data have occasionally been the outcome. Multidisciplinary approaches using information from biochemistry, serology, electron microscopy and other modern fields can indicate the basis for critical reassessment which may be facilitated by statistical treatment of taxonomic data.

The papers in this book present the proceedings of an international symposium which was organized to bring together workers on widely different aspects of the red and brown algae, to evaluate the taxonomic potential of new data emerging from their researches, and to encourage interdisciplinary approaches. The papers provide a valuable contribution to algal taxonomy in themselves, while also indicating promising lines for future taxonomic research. Taxonomists, physiologists, ecologists and phycologists will find this book of considerable interest.

THE SYSTEMATICS ASSOCIATION

The inevitable specialization which results from progress in science makes co-operation increasingly difficult. It was to ameliorate the effects of this state of affairs that the Association was founded some thirty years ago. Its membership is now world-wide. Aims include the review of the theory and practice of taxonomy and the promotion of co-operation on matters of taxonomic interest. Meetings concern topics of a general nature of interest both to neontologists and palaeontologists.

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Preface

The benthic marine algae, which include most of the red algae (Rhodophyta) and brown algae (Phaeophyta) offer challenging problems to the taxonomist. They are often difficult to study in the field, growing below the low tide mark, in inaccessible crevices, or exposed to dangerously powerful wave action. Many are morphologically variable (we avoid the word "plastic": cf. Chapman's paper!), producing widely differing growth forms under diverse habitat conditions; by contrast, different taxa may produce closely similar plants when growing under similar conditions. Fertile stages may be rare or transient, and different life-history phases of the same species may not bear the least resemblance to each other. Their habitat requirements may be difficult, indeed virtually impossible, to reproduce under laboratory conditions, and preservation of specimens under conditions allowing their customary structure to be re-examined later may also pose serious problems.

Given these difficulties, it is not surprising that marine algal taxonomy got off to a slow and confused start; that the full life-histories of many common and important species even yet are imperfectly known; that species new to science can still be found even in such apparently well-worked areas as the English Channel; and that many of the fundamental criteria used by earlier taxonomists are now being seriously questioned.

The development of increasingly sophisticated subaqua apparatus and techniques has revolutionized field study of the subtidal benthic algae, whilst improved microscopic and culture facilities have provided fresh insights into the ultrastructure and life-histories of many species. Nevertheless, the potential for morphological variation and the inevitable artificiality of the imposed environment (emphasized by many contributors) indicate that conclusions derived from culture work alone must be treated with caution; there is considerable need to identify taxonomic criteria less readily modified by environmental factors, as well as for critical assessment of the variability potential itself.

The concept of the present Symposium derived from a belief that personal interchange of information is more immediately effective and stimulatory than correspondence or the printed word and that most Symposia including the benthic algae are now too large to allow full rein to informal discussion. The Symposium was therefore organized to bring together workers on widely differing aspects of the red and brown algae; to evaluate the taxonomic potential of new data emerging from their researches; and to encourage interdisciplinary approaches. We believe that these aims were realized and that the papers read at this Symposium provide a valuable contribution to algal taxonomy in themselves, while also indicating promising lines for future taxonomic research. It is

worth mentioning that no attempt has been made to standardize the taxon level used by authors for the major divisions of algae. Some have consistently used class endings, others—division endings. Many used either class or division as it suited them. As there is hardly room for misunderstanding we have left things as they were.

Few Societies nowadays have either the finance or the available space to permit authors to be as detailed as stimulatory exchange often requires. We therefore wish to thank Academic Press, and the Systematics Association in whose series the volume appears, for placing few obstacles in the way of editors and authors, thus achieving what we hope will be regarded as a fruitful permanent record of the sessions. The value of the Symposium was due in large measure to the co-operation and support given by all concerned, so that even the concurrent student sit-in at the Polytechnic of North London, was not allowed to disrupt proceedings. We are grateful to our many helpers, but special mention must be made of the assistance given by various members of the Department of Biology and Geology, notably the Head of the Department (Mr D. Etherington), Mrs O. E. J. Etherington, Mr Richard Havely, and Mrs J. Bucklew. The Head of the Department of Geography (Dr P. F. Brandon) kindly allowed the Symposium to be held in his Department. The Director of the Polytechnic (Mr T. G. Miller) welcomed the participants and ably opened the proceedings of the Symposium. We are also grateful to the Sponsors of the Symposium for the financial backing which made it possible, i.e. to the Royal Society, the Systematics Association, the Natural Environment Research Council and the British Phycological Society.

D. E. G. Irvine
J. H. Price

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Contents

1 | Taxonomy of Red and Brown Algae

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Abstract: A review is given of the historical background to present day concepts of taxonomy in red and brown algae. The several opinions on the stabilities of the systems of classification are discussed and the new approaches of recent years reviewed.

Taxonomy is the science of classification. To quote Lam (1959): "Taxonomy is born out of classification, and classification is born out of necessity". Classification is a necessary basic feature of our life because of the great variety of natural phenomena. We apply classification procedures at all times in order to simplify the wide diversity of our experiences in relation to our environment. According to Dr Joel Hedgpeth, man's oldest profession was that of a taxonomist, since his first task in the Garden was not to work for a living—that necessity came after the Fall—but to name every beast of the field and fowl of the air. As botanists we would add ". . . and all plants of the field and water" (especially those bearing fruit!). In similar vein, Turrill (1964) pointed out that whilst animal nomenclature started with Adam (Genesis 2, 19–20), perhaps Eve dealt with plants, since plant nomenclature is said to be in better general shape than animal nomenclature. Heywood (1976), in tracing the development of systems of classification, has stated that each tribe or community would have developed a "folk taxonomy" for those plants and animals whose characteristics and properties (nutritive, toxic, medical) were well known to the tribe members. A "folk taxonomy" based on the doctrine of signatures would have been a more specialized development of limited working value. Two examples of "folk taxonomies" linked with marine algae can be cited; first, the naming of marine algae of economic value in tropical South and East Asia (Zaneveld, 1959) and, secondly, the several forms of edible seaweed ("limu") used in

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Hawaii (Abbott and Williamson, 1974). The limitations of a "folk taxonomy" are clearly very closely linked with the numbers of organisms to be classified. An estimate of the numbers of described species of plants is given in Table I. Bold (1970) gives the approximate total of living species of all plants as 350 000, of which 19 000 are algae. The very approximate number of species of red algae is 5524 according to Dixon (1973). Papenfuss (1951) states that the number of species of brown algae is about 1500, whilst Cronquist (1960) gives 2000 species.

TABLE I. Estimated numbers of described species (Grant 1963)

Flowering plants	286 000	Fungi and slime moulds	40 400
Gymnosperms	640	Protista	30 000
Ferns and fern allies	10 000	Blue-green algae	1 400
Bryophytes	23 000	Bacteria	1 630
Algae (green, brown and red)	8 675	Viruses	200

With such numbers the guidelines of our systems of classification need to be well defined.

A closer look at the terminology involved is instructive. "Classification" is derived from the Latin "classis"—a group or multitude—in fact, a term originally applied to each of the six ancient divisions of the Roman people. "Taxonomy" (a version of de Candolle's "taxonomie" of 1813) is derived from the Greek "taxis"—order or arrangement—and means "the rendering of order" (Lam 1959). By strictly applying the rules of taxonomy we are practising a "law of order" (Turrill 1964)—a structure of the system of living things, or . . . "the science of the structure of the multiformity of living nature" (Danser 1950). Such a system of living things brings us to a further term. "Systematics" is derived from the Greek "systema"—that which is "put together" (e.g. Linnaeus's "Systema *naturae*"). Systematics is a process of putting together with the purpose of obtaining an "organized or connected" group of objects. Thus—to quote Lam (1959)—"classification is an art rather than a science, taxonomy is the science behind the art, and a system is the result of both". Heywood (1976) has described the interrelationships of the three terms in more detail. Systematics is the "scientific study of the diversity and differentiation of organisms and the various relationships which exist between them". Taxonomy is "that part of systematics which deals with the study of classification, including its bases, principles, procedures and rules". The two terms are often regarded as interchangeable. Classification is the . . . "process of ordering plants in groups which are arranged hierarchically". Savory (1962), whilst pointing out the significance

of systematics in arranging both the plant and animal kingdoms into a convenient and logical order, describes the term "taxonomy" as . . . "an invention, a piece of biological jargon, a synonym with almost the same meaning". Wherever we look for precise definitions, the proximity of the two terms is evident. Thus, the opening words of Turrill's (1964) first sentence are "Plant taxonomy, or systematic botany . . ."

What are the declared goals of modern taxonomy? Davis and Heywood (1963) have put forward the following aims as those most widely accepted:

1. To provide a convenient method of identification and communication.
2. To provide a classification which as far as possible expresses the natura relationships of organisms.
3. To detect evolution at work, discovering its processes and interpreting its results.

To achieve such aims, these two authors propose a four-phased approach:

1. *The pioneer or exploratory phase:* concerned primarily with the study of herbarium material; identification, morphology, some information on occurrence, distribution and (for algae) possibly spore production.

2. *Consolidation phase:* increased knowledge with the subsequent elimination of arbitrary judgments of the pioneer phase, and frequent reduction of many names to synonymy.

3. *Biosystematic phase:* after the acquisition of cytological and biosystematic information, with the emphasis changing to micro-evolution.

4. *Encyclopedic phase:* the phase of co-ordination of 1–3.

Turrill's (1938) concept of the development of taxonomic knowledge envisages a gradient from "alpha" to "omega". The alpha taxonomy corresponds to Davis and Heywood's pioneer phase and the omega to the encyclopedic stage—a natural classification based on all possible characters and relevant data. In two recent reviews with reference to marine algal taxonomy, it is very clear that opinions have placed the status of such taxonomic studies as little beyond the "pioneer phase" of Davis and Heywood, or the "alpha" state of Turrill (Dixon, 1970b; Russell, 1973). Dixon (1970b) further points out that this lack of a taxonomic understanding of the algae is in part due to an unfortunate accident—the development of a pronounced aversion to taxonomic studies in botany at about the beginning of the present century. This would appear an odd circumstance when considered in the light of Prescott's (1951) description of 1800–1875 as the "golden age of plant taxonomy". The aversion to such studies manifested at the end of the nineteenth century and the beginning of the present one may well have been a reaction against the over-specialization on taxonomic studies of earlier years. Bower's (1938) description of his own

undergraduate experience of the official teaching of botany at Cambridge in 1875 ("... moribund in the summer and actually dead in winter ...") is illuminating. "Official" botany at Cambridge at that time was concerned principally with "... splitting analytically the varieties of *Rubus*". This was in marked contrast to the exciting developments in experimental botany then making great strides in the continental laboratories of botanists such as Sachs and de Bary. Aspiring young British botanists (such as F. O. Bower and S. H. Vines) sought their scientific inspirations abroad, and their experiences, even for short periods of time in University vacations, profoundly influenced their subsequent careers. These were, in many cases, careers of great importance in their influences on subsequent botanical teaching and research in the British Isles. Nor can we ignore the influence both at that time and in later years of the "Hofmeisterian approach" to the sequences of spore-producing and gamete-producing generations in cryptogams. This pursuit of the "new botany" (sometimes called "The Cause" by its enthusiastic disciples) was one factor leading to the eclipse of the traditional systematic botany in Britain. If, however, there was a "golden age of plant taxonomy" in the last century, to what extent was this reflected in the taxonomy of algae, and, in particular, the taxonomy of red and brown algae?

Linnaeus's "Species Plantarum" (1753), in terms of its contribution to algal taxonomy has been dismissed as being of relatively little significance, mainly because many of his "algae" were in fact liverworts (Prescott, 1951; Smith, 1951). However, his genera *Conferva* (filamentous algae), *Ulva* (membranaceous algae) and *Fucus* (algae with cartilaginous thalli) remained in this circumscription for some 50 years. The contributions of Lamouroux in the first two decades of the nineteenth century are also important. We see in Lamouroux's work the early recognition of chloroplast pigment differences in the major groups of algae. We also see early recognition of a taxonomic problem which is ever with us regarding red and brown algae—that of polymorphism. Stackhouse's (1797) *Chondrus crispus* was renamed *Fucus polymorphus* by Lamouroux (1805) and this name was in turn accepted by Stackhouse (1809) with the creation of a superfluous genus *Polymorpha*. Later Lamouroux (1813) accepted Stackhouse's genus *Chondrus*, and gathered all Stackhouse's species into the one *Chondrus polymorphus*. This polymorphism of *Chondrus* so impressed Lamouroux that he regarded the plant as a veritable "proteus" of seaweeds. More recently Thomas (1938) described 21 forms of *Chondrus*, eight of which were of his own naming.

Much importance is attached to the contributions of C. A. Agardh at the University of Lund in Sweden, and those of his son J. G. Agardh. Their recognition of the systematic value of the "cystocarp" in the taxonomy of red algae