

Proalgae and the significance of adaptive facies¹

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ABSTRACT: The new division Proalgae is proposed for a grouping of the Cyanophyta and Prochlorophyta. Algae represent an adaptive and ecological facies, not a taxonomic group, and recognition of such facies is important in evolutionary biology.

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What is an alga? Traditionally it has been any organism with oxygen-producing photosynthesis and without embryonic development. Recently some people have added another restriction, that the organism be eukaryotic. I think that this emendation is inappropriate, that it involves more than terminology, and that a new name can help resolve a subsidiary problem,

The discovery of Prochloron (Lewin, 1975, 1977) created a somewhat awkward situation taxonomically because Prochloron does not fit readily into the Cyanophyta, which were then the only known prokaryotic algae. Lewin (1976) therefore erected the new division (botanical phylum) Prochlorophyta to resolve the problem. A second prochlorophyte has recently been discovered (Burger-Wiersma et al., 1986) but not yet named.

It appears, however, that the Prochlorophyta are not distinct enough from the Cyanophyta to justify separation at the divisional level. The main distinctions between the two groups are the presence of phycobiliproteins and phycobilisomes in the Cyanophyta and the presence of chlorophyll b and, commonly, paired or stacked thylakoids in the Prochlorophyta. These are important differences but not with the major adaptive consequences normally associated with the rank of division or phylum. In addition, Seewaldt and Stackebrandt (1982), Van Valen (1982), and Stackebrandt (1983) found that on the basis of 16S rRNA fragments Prochloron mapped within or immediately adjacent to the cyanophyte radiation.

I therefore propose formally that the Prochlorophyta and Cyanophyta be united in a single division, for which I propose the name Proalgae. I have used this name informally before (Van Valen and Maiorana, 1980). The name is chosen to emphasize that the Proalgae are indeed algae; eukaryotic algae may be collectively called eualgae in an informal manner. The word "alga" is useful and has for many years not been a taxonomically explicit name. It refers to an adaptive facies, one easily recognized by nontaxonomists and even by nonbiologists. "There is no doubt that [the blue-green algae] belong to the Prokaryota. But if the similarities between blue-greens and chloroplasts, their principal mode of metabolism, or their contribution to the natural nutritional cycles are the prime matters of consideration, then blue-greens are rightly called, as before, algae" (Fay, 1983, p. 3.)

It is important to have words which refer to such adaptive facies; otherwise the very existence of these groupings may fade from view. "Tree," "yeast," and probably even "fungus" refer to phylogenetically heterogeneous adaptive facies, and there are of course many other examples. They refer to groupings, like algae, which are significant in ecological interactions. The characters which are important for these broad-scale interactions are for the most part easily recognizable, so the groupings resemble those of nontaxonomists. This resemblance should not provoke us

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to abandon such groupings out of snobbery; they are real and reflect real evolutionary processes.

Adaptive facies are the phenotypic manifestations of the occupation of adaptive zones. (On adaptive zones see Van Valen, 1971; I hope shortly to extend the discussion there.) This is not to say that occupants of a single adaptive zone must have the same adaptive facies, although this was apparently the view of Simpson (1953), but to hypothesize the converse: all organisms with the same adaptive facies occupy the same adaptive zone (at an appropriate level of zones.)

To call the Proalgae bacteria is unfortunate in several ways: it unnecessarily expands the meaning of the word "bacteria", thereby making this word less useful because there is no synonym for the normal usage; it creates unnecessary ambiguity for the word "algae" or even excises part of the useful reference set of that word; and it creates an unnecessary synonym of the word "prokaryote." That some proalgae retain an alternative bacterial-like metabolic pathway merely indicates that here, as is common elsewhere, the boundaries of the adaptive zone are fuzzy. Evolution is a continuum, even where its punctuations occur, and discrete categories necessarily create some artificiality. Nostoc is an alga and is not a bacterium.

The Proalgae are those prokaryotes which contain chlorophyll (not bacteriochlorophyll) and which use water as a hydrogen donor in photosynthesis, thereby releasing molecular oxygen. Thylakoids are normally present; two photosystems occur. A central nonpigmented region occurs within an outer pigmented zone. The cell wall is relatively thin and includes a peptidoglycan layer.

The division (or phylum) Proalgae includes the Cyanophyceae and Prochlorophyceae as classes. Each class, although not necessarily its surviving membership, is presumably paraphyletic in that members of it have become chloroplasts in eukaryotes. Perhaps one or both classes are also paraphyletic within the Prokaryota. This should not matter in the least. Paraphyletic taxa are quite as good as holophyletic ones; both kinds are monophyletic and are adaptively unified segments of a phylogeny (Van Valen, 1978).

It is also possible that when more is learned about prokaryote phylogeny and diversity it will become necessary to change the limits or definition of the Proalgae. I explicitly intend the classes Cyanophyceae (apparently named by Sachs, 1874) and Prochlorophyceae (named by Lewin, 1977) to be central.

Proalgae, divisio nova: Algae procarioticae; Prokaryota quae habent chlorophyllum (non bacteriochlorophyllum) et quae liberant O_2 in photosynthesi.

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