

Mutualism

The Forgotten Concept in Teaching Science

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The development of a strong sense of mutual obligation toward others in local, regional and global communities is needed if we want to solve the important social and environmental problems of our planet and thus build an ecological or sustainable society. Science education is generally perceived as a way of developing this scientifically literate society. Currently, however, many educators believe that science education in modern society should also be directed toward the student's understanding of the interdependence of individuals and groups of individuals with each other and with their environment (e.g., Bybee 1979; Hurd 1989). For the goal of human survival on the living planet Earth, mankind needs to develop the "far-reaching love and compassion for humanity" (Bybee 1979) that can only be done in the presence of other human beings. This positive collaboration may lead to mutual respect and a sense of moral responsibility among humankind. A study of mutualism in science education is one way of enhancing the love and respect that will be necessary to achieve ecological goals.

However, mutualistic relationships have received low emphasis in biology and ecology textbooks at both the college and school level. On the opposite side, competition and predator-prey interactions have dominated topics related to existence and survival relationships among living organisms. Mutualism is a form of symbiotic relationship in which two or more species live in intimate relationship with each other to the benefit of all. Competition, on the other hand, is the "use or defense of a resource by one individual that reduces the availability of that resource to other individuals" (DeSanto 1978, p. 234). There is speculation that the emphasis on competition rather than mutualism has, whether directly or indirectly, caused the belief that balance in nature can be achieved and maintained only through competition.

From Thomas Malthus and Adam Smith to Charles Darwin and Herbert Spencer, the idea of competition began to be recognized as an important factor in na-

ture, a basic element in the universe, and/or the ultimate source of human progress (Boucher 1985). Since the 19th century human progress through competition has become the dominant theme in both the natural and social sciences. Even Frederick Clements (a dominant figure in American ecology in the early twentieth century) and his British colleague, Arthur G. Tansley, devoted little attention to non-competitive kinds of relationships among living organisms. In short, regardless of the balance that may exist in nature, up to the early 1970s most ecologists represented it as being maintained by competition for resources such as shelter, food and energy (Boucher 1985). Indeed, regardless of the early calls for the tenets of competition theory (e.g., Ayala 1969), until the end of the 1970s the conventional wisdom of competition was widely regarded as the major selective biological process in shaping the pattern of natural communities (e.g., Cale, et al. 1989; Wiens, 1977).

The continued emphasis on competition has pushed mutualism out of favor in modern ecology teaching (Boucher 1985). Yet, as Risch and Boucher (1976) notice:

Twentieth century ecology, while usually shying away from analogizing the natural and social worlds, has continued the tradition of seeing antagonistic interactions as the basis of community organization. Its development of theoretical bases in the twenties and thirties, including the competitive exclusion principle and the Lotka-Volterra predator-prey equations, further encouraged studies along these lines. (p. 9)

Today, however, a new generation of ecologists and biologists have again begun to doubt the capacity of competition and predation alone to explain the distribution and abundance of living organisms. Doubt such as this stems from the fact that "... at this point in time the results of a great deal of theory and field and laboratory study on competition and predation have met with limited success in explaining community, stability, diversity, and succession" (Risch & Boucher 1976, p. 8). Furthermore, as

Schmookler (1984) pointed out:

The survival of life forms depends on their ability to integrate into an evolving environment. The main characteristic of their process is not competition between species, but is the ability of the organism to integrate or fit with a particular ecological niche. This would also be true for human society, even with our ability to modify our environment [and the role which we play within our community]. (p. 10)

According to Boucher (1985), as early as 1902, Peter Kropotkin pointed out in his best selling book *Mutual Aid* that competition between animals was not enough to explain the complexities of nature, especially the progress of organic life. Kropotkin showed how cooperation, as well as competitiveness, can help organisms to survive and reproduce. Mutualism seems to be more powerful in nature than biologists and ecologists once assumed.

Beginning with Van Beneden, Alfred Espinas, Roscoe Pound, Eugenius Warming and Peter Kropotkin and continuing in the works of Warder C. Allee, Steven Risch, Douglas Boucher, John Wiens, Joseph Jehl, etc. the concept of mutualism began to be recognized as an important factor in the interaction in nature and in the determination of community structure. Mutualism has been proven, theoretically and empirically, to play a key role in "... determining the abundance and distribution of organisms" (Risch & Boucher 1976, p. 8) and in turn in the balance of nature (Risch & Boucher 1976; Wiens 1983; Jehl 1984; Boucher 1985). Yet little attention has been given to mutualistic relationships, either among living organisms or human communities, in school science textbooks as well as college biology and ecology textbooks. It is my argument that mutualistic relationships are too important to be passed over either in secondary school education or the college level, especially since mutual relationships are extremely widespread and important (Odum 1975).

Students receiving the theory of competition as being the fundamental process of nature without equal emphasis on symbiosis and cooperation are getting only half the story. In the long run, these students become anthropocentric in their thinking, regardless of the ecological knowledge they might have learned in their classrooms. Competition alone will not bring solutions to, for example, the three most difficult problems mankind is facing: nuclear war, overpopulation and the acceleration of ecological crises. If we fail to teach concepts of mutualistic relationships, efforts to solve ecological crises might be fruitless. Without balancing conceptions such as mutualism, competition leads to exclusively anthropocentric thought, and it might lead, directly or indirectly, to self-destructive behavior.

Mutualism is not something new. Mutualistic relationships have always existed in nature. Evidence for

the idea of mutualism can be traced back into 1500 B.C. (Abmadjian & Paracer 1986). According to Boucher (1985), both Herodotus and Aristotle used mutualism as an example of nature's balance. For example, the bird that eats leeches from the mouth of a crocodile is cited by both of these ancient writers. Pliny pointed out how:

... friendships occur between peacocks and pigeons, turtle-doves and parrots, blackbirds and turtle-doves, the crow and the little heron in a joint enmity against the fox kind, and the goshawk and kite against the buzzard. Why, are there not signs of affection even in snakes, the most hostile kind of animals? We have mentioned the story that Arcady tells about the snake that saved his master's life and recognized him by his voice. (Cited in Boucher 1985, p. 8)

The universe is full of perfect adaptations developed by whatever means, and mutualism—different kinds of organisms fruitfully co-existing and aiding each other—is but one example.

But the question now is what we as biology teachers should do so people realize that mutual cooperation between different kinds of organisms is just as important in helping each other to survive. First, as biology teachers, we need to explain and illustrate symbiosis mechanism not only through microscopic organisms but throughout all the levels of biological and social organizations particularly if we want to replace the image of mankind as the conqueror with the image of mankind as an integral part of the natural world. Second, our thinking must change. According to Zlotnik (1986):

The dangers we face arise from our own thinking, from our ideas of the "enemy," our ideas of power, authority, and security, of knowledge and truth—and of ourselves. Our world is a dangerous place, and it will remain so until we change the ways we think about one another and our place on the earth. (p. 35)

Thus, we should start by offering students alternative ideas. We should show them that there might be other ways of seeing and understanding the relationships among living organisms in nature. We should start by offering students opportunities to think in alternative ways when they face, for example, the question of what desires and attitudes they ought to have about the environment. As Suzuki says (1986) in his television series *Planet For The Taking*:

... if we are trained to believe that aggression and strife and competition for commodities and for power are what makes the world go around, then we will interpret the world that way. But if we shift our perspective a little, shift expectations, then sometimes it is possible to see the world differently. Sometimes it is even possible to see new things.

It follows that if we are taught, for example, that there are in nature other relationships for achieving stability and success besides competition, aggression and predation, we might develop different attitudes, for

not only to each other, but to non-human organisms and the whole of nature.

Therefore, if our children are brought up to respect different kinds of mutualistic relationships, they might then understand the merit of mutual partnerships in developing the qualities needed for improving world peace, human life and ecological sustainability. Since biology is entering a new phase in its knowledge revolution (e.g., Hurd 1989), biology instructors are going to face new challenges in the 1990s, and developing a sense of balance between competition and mutualism in their teaching of biology is going to be one of them. Finally, let us (at least for a moment) consider what Odum (1975) wrote:

In one sense mutualism is a model for a regulated ecosystem where even parasites and predators are useful in the sense that they "cooperate" for mutual survival. Man has made considerable progress in cooperation with his own population, and he is now also turning greater attention to achieving greater cooperation with other organisms for mutual benefit. There is much to be gained if we can transform negative interactions into positive ones. . . . man thrives best when he functions as a part of nature rather than as a separate

unit that strives only to exploit nature for his immediate needs or temporary gain (as might a newly acquired parasite). Since man is a dependent heterotroph, he must learn to live in mutualism with nature; otherwise, like the "unwise" parasite, he may so exploit his "host" that he destroys himself. (p. 142)

Many new social, economic and political trends seem to be heading in this direction; so too should science education.

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