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The Theory of Utilitarianism as Complement of Interspecific Interactions of Commensalism, Cooperation and Mutualism Puzzle

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Abstract

Biotic interactions and their categorization are discussed in this article with examples from the international literature. The aim is to clarify certain terms that presumably raise questions in relevant research. The necessity of borrowing terms from the human sciences such as that of utilitarianism is established in order to improve the descriptions of the various individual terms of the symbiosis phenomenon. The spatial and temporal context of a relationship should be thoroughly considered in order for descriptions to be as true to reality as possible.

Keywords: Commensalism; Ecological Triangles; Symbiotic Interactions; Molecular Biology

Introduction

Theoretically when two species coexist, the relationship they develop with each other may be indifferent, favorable or unfavorable [1]. However, the complexity of the interspecific interactions and interdependencies between two or more species is complicated when the existence of a species presupposes the existence of at least another two or more species. A typical case is Ross & Sutton's [2] reference to ecological triangles (Gastropod - Anomura - Anemone). The scientific interest in interspecific interactions remains high on the agenda of many scientific groups [3-7]. Parmentier, et al. [5] have suggested ways of clarifying the boundaries of interspecific interactions by raising well-founded questions on the need to establish a method of measuring these boundaries. However, the theoretical basis of the range of biotic interactions is considered imperfect in many cases or at least with many weaknesses. According to Zapalski, et al. [8] a neutral interaction may be the absence of interaction, but proof of its absence is considered to be an impossible case for investigation. Therefore, it may be regarded as a concept inappropriate for empirical science. In this article an attempt is made to clarify certain biotic interactions with the use of examples that are known from international literature and that contribute to the development of a wider discussion on the whole subject.

Results & Discussion

The appeal of studying symbiotic interactions was highly enhanced by the development of molecular biology [3]. Molecular biology, along with evolutionary biology, now supports the formation of a common perception with humanities studies, which lend terms and definitions for

the interpretation of complex biotic interactions. Thus, the term Utilitarianism, proposed by John Stuart Mill, et al. in his homonymous work in 1861, was recovered from international literature,. However, according to Driver [9] the definition of Utilitarianism has its roots in the mid-15th century. However, Jeremy Bentham, et al. and his "principle of the greatest happiness" is attributed to be J. S. Mill's inspiration for the formulation of the theory of Utilitarianism. Underlying a moral-philosophical view, Utilitarianism is "the view that the rightness of an action depends on whether it contributes to the happiness of the person performing it, as well as everyone affected by it".

The use of a conceptual diagram for the study of biotic interactions by Parmentier, et al. [5] was my own source of thought, regarding the individual categorization of biotic interactions, which offer only positive benefits to partners. These relationships are still reflected in the definitions Cooperation, Commensalisme and Mutualisme (Table 1).

1) Mutualism	Each of the two species participating in the symbiosis cannot survive, develop and reproduce without the presence of the other. That is, the two species coexist.
2) Commensalism	It is the partnership that develops between a commensal species and a host. From the cooperation, the commensal benefits but the host, neither benefits nor is harmed.
3) Cooperation	It is the cooperation of a conspecific and a host from which both partners derive some advantage, but their survival does not depend on their cooperation.

Table 1: Interspecific biotic interactions with beneficial effects.

For Mutualism, two typical examples were distinguished in the international literature. The first concerns the symbiosis between the decapod *Pagurus prideaux* and the sea anemone *Adamsia paliata*. Both species are recorded as species that almost always live together. The decapod, on the one hand, provides two important benefits to the anemone: (1) The anemone's foot disc covers any worn parts of the gastropod shell used by the anemone as residence [10], and (2) it provides sufficient antipredatory behavior against cephalopod molluscs [2]. *Adamsia palliata*, on the other hand, provides a means of transport for easier predation, but also food parcels that are dispersed in the water column when the host, the Anomura, shreds its food. The second example is that of the fish *Amphiprion* (Pomacentridae: Pisces) and the sea anemones of the family Stoichactiidae [10,11]. The benefits of both partners from symbiosis are particularly important for the whole range of their biological needs (Table 2). In any case, their interactions are considered particularly important for their survival. They are rarely found as individuals. Their interactions include territoriality, diet, antipredatory behavior, reproductive success and body hygiene.

In Commensalism the host is almost always larger and neither benefits nor is harmed by the commensal. Although this view is probably difficult to confirm [8], the observed biotic interactions, in general, indicate that the commensal exploits the host according to the following patterns: (1) Ensuring protection as in the case of *Gobius buchichi* which occurs very often with the sea anemone *Anemonia viridis* [12]. However, this interaction is not exclusive. Both the fish and the anemone also occur as individuals in the sublittoral zone. (2) Guaranteeing settling habitat as in cases of Phoretism, where various species of Cirripedia (Crustacea), settle on the body of marine mammals (e.g. whales) and reptiles (sea turtles), while at the same time exploiting the movements of the host for better feeding behavior, and (3) Nutritional benefits. According to Nicholson-Jack, et al. [13] the fish *Remora remora* consumes large amounts of *Mobula birostris* waste.

The concept of cooperation in the international literature is often confused with the concept of mutualism and commensalism, especially when a biotic interaction is not sufficiently studied. The levels of cooperation followed by two species, a host and a commensal, can be multiple and complex, but they are never binding for the survival of the species. Possibly, they are decisive for a period of time in their lives, but not for life, as is the case with mutualism. The complexity of the cooperation is also related to the number of advantages or benefits that the partners derive from each other. Examples include: (1) Individual Cleanliness, (2) Habitat Suitability, (3) Foraging, (4) Predator Predation, (5) Antipredatory Behavior, (6) Reproductive Ability (Table 2). However, the importance of benefits seems to play its role as well. For example, the priority of anti-predation behavior is one thing and the incidental predation of predators is another.

In the context of table 2, an attempt is made to include the concept of utilitarianism, as an additional piece of the puzzle of interspecies interactions. Biotic interactions that provide positive advantages to partners are arranged in a hierarchy of interconnectedness, as a continuum that begins with simple cooperativity to culminate in mutualism. Between these two extremes we find commensalism

and utilitarianism. In cooperation (Cr.nil./H.ar.) loose commitments are found between partners which may at some stage in their lives be unilaterally beneficial to one of the two partners. In commensalism (A.v./I.ph., A.v./L.m., C.s./Al.p.) the connections show greater interdependence. However, the periodicity of relationships is part of their biology. In utilitarianism (P.al./C.par.), we find even greater interdependence depending on living limits and life cycles of the partners, while in mutualism (St.h./Am.s.) this becomes almost absolute, as none of the two partners can survive without the presence of the other.

In conclusion, all types are a form of symbiosis. The partners coexist but the interdependence relationships differ mainly in time, whether measured in terms of the life cycle or in terms of seasonality. The thoughts of Parmentier, et al. [5] to discover methods of valuing or evaluating the interactions is judged as particularly important for the future of research. The concept of utilitarianism seems to help in this direction [14-16].

Benefits	A.v./I.ph.	A.v./L.m.	P.al./C.par.	St.h./Am.s.	Cr.nil./H.ar.	H.inf./I.hom	C.s./Al.p.
Individual Cleanliness	+/+		+/-	+/+	+/-	+/-	
Habitat Suitability	+/+	+/+	+/+	+/+	+/-	+/-	+/+
Foraging	+/+	-/+	-/+	+/+	-/+	-/+	-/+
Predation – predators	+/-	+/-		+/+			+/-
Anti-predatory behavior	-/+	-/+	+/+	+/+		+/-	+/+
Reproduction	-/+			-/+			

Table 2: Advantages or benefits of biotic interactions.

Individual cleanliness, both the host and the commensal ensure, from the partner's actions, sufficient cleanliness of their skin from food residues or from parasites that could potentially be pathogenic. **Habitat Suitability**, the host looks for a suitable installation habitat, while the commensal acts as a biocleaner and preserver of the surrounding area. **Foraging**, both partners (host and commensal) benefit from food shares from their feeding behavior. **Predation – predators**, the species coexistence acts as a baited trap for various predators captured by the coexistence partners. **Anti-predatory behavior**, securing shelter and protection from predators due to coexistence. **Reproduction**, the existence of the biotic interaction is a prerequisite for any reproductive process.

Abbreviations, A.v./I.ph.= *Anemonia viridis/Inachus phalagium*, A.v./L.m. = *Anemonia viridis/Leptomysis mediterranea*, P.al./C.par.= *Pagurus alatus/Caliactis parasitica*, St.h./Am.s.= *Stichodactyla haddoni/Amphiprion sebae*, Cr.nil./H.ar.= *Crocodylus niloticus/Hoplopterus armatus,* H.inf./I.hom= *Hypsorphrys inflata/Isanthus homolophylous,* C.s./Al.p.= *Cryptocentrus steinitzi/Alpheus purpurilenticularis.*

Symbols denote, (+) = benefit or advantage, (-) = no effect

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