Traits don't evolve for the benefit of the species but because they increase individuals´ inclusive fitness

Carsten Schradin[1,2,*]

[1]CNRS, UMR7178, 67087 Strasbourg, France

[2]School of Animal, Plant and Environmental Sciences, University of the Witwatersrand, South Africa.

[*]carsten.schradin@iphc.cnrs.fr

In a recent publication, (Besedovsky and Del Rey, 2022) asked why the immune system, which evolved to protect the individual against disease, sometimes causes death. They argue that lethal cytokine overreaction evolved for the benefit of the species by negative selection of individuals that would otherwise spread the infectious disease.

Since the 1960s it has been realised that traits do not evolve for the benefit of the species but because they increase individual fitness (Williams, 1966). If an allele leads on average to a higher fitness in its bearers than in individuals not bearing this allele, then its frequency in the population will increase. This is why biologists agreed that the best level to study evolution is the individual. Other levels of organisation (gene, cells, groups, populations) can also be mathematically considered. Explaining evolution on a higher than individual level via the Price equation is sometimes called "new group selection" though the term "multi-level selection" is preferred. The Price equation is mathematically identical to kin selection on the individual level, which states that traits that favour the distribution of its underlying alleles

can spread not only by directly benefitting the carrier, but also if it benefits close kin that have a high probability of carrying the same allele, which sums up to inclusive fitness (Frank, 1995; Gardner).

Besedovsky & Del Rey (2022) review that cytokine storms during infections can be lethal. They use the old group selection theory when they say that traits "contribute to evolution as long as the survival of one individual would not threaten other members of the group". This has been proven to be wrong by multiple studies in behavioural ecology, where males and females kill offspring of other group members, and the strategy of dominant individuals is to increase their fitness by decreasing the fitness of subordinate group members.

The fact that cytokines causing cytokine storms are 700million years old implies that they are evolutionary extremely successful, i.e. that they have on average a positive effect on individual fitness, even if in some cases they lead to disease and death. Instead, Besedovsky & Del Rey (2022) suggest that negative selection (the removal of deleterious alleles) can lead to the spread of the very same alleles as it eliminates individuals from the population that would otherwise spread infectious disease. The suggestion that removal of alleles could make these alleles spread in the population is problematic. Individuals which die cannot spread the alleles anymore. If these alleles nevertheless spread, then this must be due to positive selection, either by 1. the same individuals having high reproductive success due to the same allele in a life history stage before death (Straub and Schradin, 2016), and 2. the mean lifetime reproductive success of individuals carrying these allele being higher than of other individuals.

In sum, their conclusion that "Immune-mediated negative selection can favour emergence and expansion of species" is based on old group-selection arguments which has to be rejected.

References

Besedovsky, H.O., Del Rey, A., 2022. To protect or to kill: A persisting Darwinian immune dilemma. Brain, Behavior, and Immunity 103, 205-214.

Frank, S.A., 1995. George Price's contributions to evolutionary genetics. J. Theor. 373- 388 175.

Gardner, A., The Price equation. Current Biology 18, 1-4.

Straub, R.H., Schradin, C., 2016. Chronic inflammatory systemic diseases – an evolutionary trade-off between acutely beneficial but chronically harmful programs. Evolution, Medicine, and Public Health.

Williams, G.C., 1966. Adaptation and Natural Selection. Princ. Univ. Press, Princeton, New Jersey.