On Human Population Growth, Natural Selection, and the Tragedy of the Commons

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Introduction

In two recent issues of *Conservation Biology*, Gehrt (1996) and Kay (1997) discussed some aspects of the "human population problem." Gehrt advocated the promotion of education and ecocentric ethics to change human population growth and behavior. Kay suggested, on the other hand, that a human population problem does not exist because the real problem is evolution by natural selection. Therefore, neither education nor ethics can offer solutions.

I comment on both contributions and correct some misconceptions, especially one about "the laws of evolution." More specifically, I want to address (1) what the human population problem consists of and (2) whether it really is a problem of natural selection.

What Is the "Human Population Problem"?

Gehrt (1996) discussed human *population growth* as one of the major threats to biodiversity. In his search for a way to engage people in this topic, he is concerned about the "inability of most people to comprehend the magnitude of large numbers" (p. 900). Though he correctly added human *behavior* to the agenda, he did not realize that one solution may lie in this term.

Neither the absolute number of human beings nor their increase rate per se poses a problem to biodiversity. This view is in clear contrast to an opinion that recurred in this journal: "If one does not know how many people walk the globe . . . , one cannot reasonably be said to comprehend the situation" (Meffe 1994:310; cf. Meffe et al. 1993; Gehrt 1996). Even if most people *could* imagine what "5.5 billion people" means, however, this does not help at all when they have no idea how large the Earth is.

The problem consists of three components, only one of which is the size of the human population. The other two components are the total quantities of natural resources and their per-capita consumption rates (e.g., Ehrlich et al. 1977; Meadows et al. 1992; Cohen 1997).

Population numbers are thus not sufficient for the comprehension of the human population problem. In fact, they are not even necessary. This is because the parameters of human population and total quantity of natural resources can be summarized in a single measure: amount of natural resources available per capita. This measure is comprehensible without special training in imagining astronomical numbers—in contrast to the number of human beings and the area of the Earth. As an aside, evolutionary epistemology has no difficulties in explaining why humans are unable to imagine such magnitudes: there has simply never been a necessity to do so during our evolutionary history. A per-capita share of a large amount of resources, on the other hand, is far easier to comprehend. It is also easily understood that this personal share of resources will diminish when the number of people increases—without the need of knowing any absolute number—as well as when other people increase their consumption rates.

Attempts to quantify the per-capita resource availability, which is also referred to as environmental space (cf. Hille 1998), have already been undertaken in connection with the project Sustainable Europe (Spangenberg 1995 and 28 national studies cited in Carley & Spapens 1998).

There is a further danger in solely addressing population growth as *the* problem: it passes the responsibility for solving the problem either explicitly or implicitly to the "developing" countries, which have the highest rates of population increase. This perception is not only counter to the global distribution of consumption but also to the fact that the "developed" countries are the most overpopulated.

Paper submitted April 2, 1998; revised manuscript accepted November 4, 1998.

Conservation Biology, Pages 447–449
Volume 13, No. 2, April 1999

Is Natural Selection the Problem?

Kay (1997) did not consider the population problem a human one. He relied heavily upon Hardin's (1968:1246) "tragedy of the commons" in quoting: "Those who have more children will produce a larger fraction of the next generation than those with more susceptible consciences." He extended this view with his own words: "once people fully understand all their options . . . they will rationally . . . have more children as fast as they can" (Kay 1997:1447). In other words, population growth is inescapable because restricting reproductive output is detrimental in terms of fitness and thus is not evolutionarily stable. Kay (1997:1448) concluded that unless "someone figures out how to repeal the laws of evolution," natural selection will render impossible the solution of tragedies of the commons.

The point that Kay failed to see is that the human species began to change the laws of *genetic* evolution already some 10,000 years ago. The natural selection of genetic replicators has lost some of its influence and has been modified as a consequence of the growth of culture. Culture "can modify selection pressures, . . . generate new evolutionary mechanisms, . . . produce time lags in the action of any selection, . . . affect the genetic response to selection, [and] generate atypically strong selection pressures" (Feldman & Laland 1996). Human behavior is governed by both genes and *memes*—to use the word Dawkins (1989) introduced for "cultural replicators." The crucial point, as I have stated elsewhere (Pichl 1997), is that memes can successfully spread even when the behavior they "encode" is maladaptive in terms of genetic fitness. Therefore, it cannot simply be assumed that maladaptive human behavior is evolutionarily unstable, unless it has been demonstrated that the respective behavior is uninfluenced by memes.

This perception can be applied to the case of human reproduction. In most contemporary societies, family size is not under the sole control of heritable fitness traits. In Westernized societies, memes may even play the single most important role in determining human lifetime reproductive success (Jacquard & Ward 1976). Sexual enlightenment, the accessibility of contraceptives, or the personal or religious conviction that having children is desirable are not heritable traits. Having more children will therefore not necessarily outcompete other strategies when family size is determined by one or more such memes.

Still, one can object that natural selection can act on reproductive performance as long as memes do not have full control of human behavior. This may be especially valid in countries with high population growth rates. But all three factors that determine a trait's per-generation response to selection—variance and heritability of the respective trait and selection intensity (Stearns 1992)—are small in humans (Jacquard & Ward 1976). Therefore, the role of natural selection may not be zero, but it will act in time scales several orders of magnitude larger than the ones we are talking about when we address environmental problems. The human population problem will have to be solved some centuries or millennia before natural selection possibly will be able to counteract these efforts. Successful memes are good candidates for outcompeting even those rudimentary remnants of natural selection that act on humans. This is because it is not life-history traits that are selected in Westernized societies but psychological factors (Jacquard & Ward 1976), and because the generation time of memetic evolution is somewhere between hours and months, compared to 30 years for genetic evolution.

There is a further objection: even if one assumes that contemporary societies are totally uninfluenced by natural selection, we still bear the genetic heritage of this selection past in our genes. Some authors argue that this heritage is so dominant that only these selected strategies will be stable human behaviors (e.g., B. S. Tullberg & J. Tullberg 1996). I am skeptical of this view (Pichl 1997), but it is nonetheless important to realize that the same authors emphasize that human behavior is based above all on reciprocity (J. Tullberg & B. Tullberg 1994; B. S. Tullberg & J. Tullberg 1996). Thus, they do not share Kay's deterministic pessimism because reciprocal behavior, together with our unique capacity for conscious foresight, enables humans to manage commons without overexploitation (e.g., Ostrom et al. 1992; Ostrom & Gardner 1993; cf. Burgerhoff Mulder 1998).

Kay's other statement is readily testable. If full comprehension of options leads people to maximize their genetic fitness, numbers of children should be higher in societies where knowledge about the mechanisms of evolution is most easily accessible. It is, however, a known phenomenon that increases in educational standards are followed by decreases in family size (Lorimer 1954; Kasarda et al. 1986).

Falsification of the belief that tragedies of the commons are inescapable comes not only from population politics but also from land use. Cattle densities on pastures in the European Alps were from the early Middle Ages to our century regulated in a way that did not result in environmental degradation (Grass 1948; Netting 1981; Bätzing 1991). Alpine pastures were commons in most parts of the Alps and are very sensitive to overexploitation. Other examples also show that commons were frequently run with foresight over periods of several centuries and still are run, wherever farmers or fishers had the possibility to regulate their affairs themselves, without interference from bureaucrats or despots (Ostrom 1990; Ostrom & Gardner 1993). Regarding land use, it is, therefore, crucial to promote small-scale democracy and to decentralize decision structures in order to avoid tragedies of the commons.

In conclusion, the human population problem has to be solved at two equally important levels, population

growth and per-capita consumption of natural resources. Natural selection is no excuse for refraining from action. Efforts to solve these problems have to be at least as intense in industrialized nations. The necessary tools include the ones mentioned by Gehrt, education and ethics, and by Kay, legislation—used in combination and in addition to small-scale democracy.

Acknowledgments

I thank I. Folstad, S. D. Gehrt, and K. Sieving for interesting and helpful comments.

Literature Cited

Bätzing, W. 1991. Die Alpen. Entstehung und Gefährdung einer europäischen Kulturlandschaft. Beck, München, Germany.

Burgerhoff Mulder, M. 1998. The demographic transition: are we any closer to an evolutionary explanation? Trends in Ecology and Evolution **13:**266–270.

Carley, M., and P. Spapens. 1998. Sharing the world: sustainable living and global equity in the 21st century. Earthscan, London.

Cohen, J. E. 1997. Population, economics, environment and culture: an introduction to human carrying capacity. Journal of Applied Ecology **34:**1325–1333.

Dawkins, R. 1989. The selfish gene. 2nd edition. Oxford University Press, Oxford, United Kingdom.

Ehrlich, P. R., A. H. Ehrlich, and J. P. Holdren. 1977. Ecoscience: population, resources, environment. 3rd edition. Freeman, San Francisco.

Feldman, M. W., and K. N. Laland. 1996. Gene–culture coevolutionary theory. Trends in Ecology and Evolution **11:**453–457.

Gehrt, S. D. 1996. The human population problem: educating and changing behavior. Conservation Biology **10:**900–903.

Grass, N. 1948. Beiträge zur Rechtsgeschichte der Alpwirtschaft vornehmlich nach Tiroler Quellen. Schlern-Schriften **56:**1–285.

Hardin, G. 1968. The tragedy of the commons. Science **162:**1243–1248.

Hille, J. 1998. The environmental space concept: implications for policies, environmental reporting and assessments. Office for Official Publications of the European Communities, Luxembourg.

Jacquard, A., and R. H. Ward. 1976. The genetic consequences of changing reproductive behaviour. Journal of Human Evolution **5:** 139–154.

Kasarda, J. D., J. O. G. Billy, and K. West. 1986. Status enhancement and fertility. Academic Press, Orlando, Florida.

Kay, C. E. 1997. The ultimate tragedy of commons. Conservation Biology **11:**1447–1448.

Lorimer, F. 1954. Culture and human fertility. United Nations Educational, Scientific, and Cultural Organization, Zürich, Switzerland.

Meadows, D. H., D. L. Meadows, and J. Randers. 1992. Beyond the limits: confronting global collapse, envisioning a sustainable future. Earthscan, London.

Meffe, G. K. 1994. Human population control: the missing awareness. Conservation Biology **8:**310–313.

Meffe, G. K., A. H. Ehrlich, and D. Ehrenfeld. 1993. Human population control: the missing agenda. Conservation Biology **7:**1–3.

Netting, R. M. 1981. Balancing on an alp: ecological change and continuity in a Swiss mountain community. Cambridge University Press, Cambridge, United Kingdom.

Ostrom, E. 1990. Governing the commons: the evolution of institutions for collective action. Cambridge University Press, Cambridge, United Kingdom.

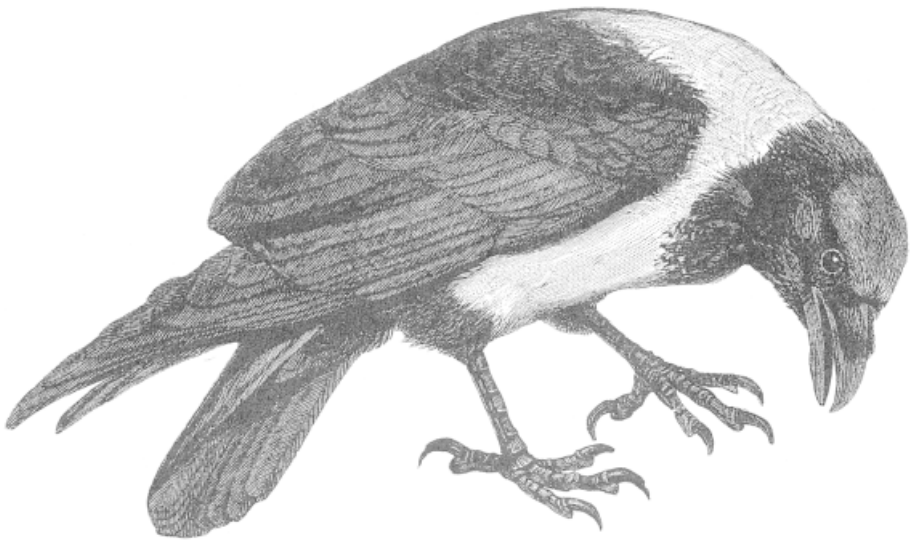
Ostrom, E., and R. Gardner. 1993. Coping with asymmetries in the commons: self-governing irrigation systems can work. Journal of Economic Perspectives **7(4):**93–112.

Ostrom, E., J. Walker, and R. Gardner. 1992. Covenants with and without a sword: self-governance is possible. American Political Science Review **86:**404–417.

Pichl, H. 1997. On human altruism and selfish memes. Oikos **79:**619–620.

Spangenberg, J., editor. 1995. Towards sustainable Europe: the study. Coordination Européenne des Amis de la Terre, Bruxelles, Belgium.

Stearns, S. C. 1992. The evolution of life histories. Oxford University Press, Oxford, United Kingdom.

Tullberg, B. S., and J. Tullberg. 1996. On human altruism: the discrepancy between normative and factual conclusions. Oikos **75:**327–329.

Tullberg, J., and B. Tullberg. 1994. Naturlig etik. En uppgörelse med altruismen. Lykeion, Stockholm.