Green Flame:

Kropotkin & the Birth of Ecology

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The pre-eminence of environmentalism in the 21st century is a novel political and historical development. Ecology is a new body of scientific description and knowledge upon which social, economic, political and ethical ideas and practices have become premised. Ecosystem science suggests that political, social and economic arrangements must be compatible and ideally optimize natural ecological processes. Harming ecosystems is considered ethically, politically and ecologically wrong.

There are profound ecological elements and sentiments within ancient literature. But, it was not until the beginning of the last quarter of the 19th century that ecological insights or observations were moulded into conceptual relationships and began forming a coherent environmentalism. "Self-definition" and conscious association with this new political outlook "arose in the 1920s." It did not "acquire a proper name until the early 1970s ... when the scientific roots of ecologism merged into a political discipline, to become an ideology."1

Peter Kropotkin (1842-1921) is a leading historical and philosophical figure in the early development and emergence of environmentalism. Kropotkin's major works were all republished and discussed in the 1970s such that his late 19th century ideas and insights influenced and shaped the direction and definition of the early-modern environmental movement. Kropotkin was the first person to mould proto-ecological concepts within the then fledgling fields of economics, agricultural science, conservationism, ethology, criminology, city planning, geography, geology and biology into a coherent new scientific outlook combined with a radical political or social ecological program for rejuvenating society and our relationship with the Earth. It is instructive to re-examine Kropotkin's scientific career because his multi-disciplinary contribution to ecological science and environmental politics is obscured by the fact that he defined himself as a geologist and anarchist and not as an environmentalist.

Kropotkin during the 1860s devoted his youth to Siberian exploration and orography (study of mountains or Alpinism). He gained celebrity as the first man to correctly map the physiography of north-east Asia.

In his late twenties, Kropotkin undertook pioneering investigations of ice ages involving a geological expedition to Scandinavia. Kropotkin's earlier work in Siberia and his thesis on palaeo-glaciology are landmarks in the development of the science of geomorphology. Kropotkin's conclusions were also a pioneering contribution to our scientific knowledge of climatic change upon Earth in the very recent past (geologically speaking).

In 1872, when visiting the Jura Mountains in Switzerland, Kropotkin was impressed by the anarchist watchmakers of Sonvillier. These free-artisans generated power from mountain streams to operate their machinery and organized industrial affairs upon the basis of workers' self-management within the context of a federation of villages. Kropotkin's experiences in the Jura led him to declare himself an anarchist revolutionary.

Kropotkin delivered his influential and original thesis about ice ages to the Russian Geographic Society a few hours before his arrest as a revolutionary outlaw. Kropotkin's two-volume study upon glacial geology was based upon the results of his Scandinavian fieldwork. The first volume was written while he was imprisoned in the Tsar's fortress and published in 1876.

Kropotkin eluded his guards and escaped to Edinburgh the same year. There he met Patrick Geddes, an outstanding biologist (symbiosis), environmental-geographer and fondly remembered city planner in British India. Kropotkin proceeded to London, where he met geographer John Scott Keltie, then editor of the famous British scientific journal Nature, in which Kropotkin had previously published articles. Kropotkin moved to Switzerland and then France at first working on the Russian and Siberian sections of a geographical dictionary edited by Keltie. Kropotkin continued his geographical work through his new association with the French geographer Elisee Reclus, whom he met in 1877. Reclus was a Paris Communard and confident of Bakunin. Kropotkin helped Reclus with his Universal Geography. This was Reclus' grandest undertaking, and Kropotkin is credited with parts of volumes 5 and 6, covering Finland, European Russia, and Siberia. Reclus' monumental 19-volume geography of the Earth was the last ever such work conceived by a single mind. In his acclaimed first book The Earth (1864, 2 vols.), Reclus was among the first to articulate in a systematic and scientific way the modern idea of the Earth as a dynamic system of systems. The final chapter of The Earth must be among the first social-environmental manifestos ever penned.

Urban and Social Ecology

In 1883, Kropotkin was arrested in France for political reasons and sent to jail, from where he was deported to England in 1886. Briefly in Paris after his release, he investigated the city's market gardens, an interest he had developed whilst tending the prison's vegetable plots. The Paris gardeners used industrially advanced organic forms of small-scale commercial horticulture, and such approaches to food production are an integral component of his urban ecological-anarchist vision.

Kropotkin was exiled in England for much of the remainder of his long life. Whilst lecturing around Britain, he researched its horticultural practices. He made trips to Guernsey to investigate their intensive horticultural systems and was impressed by the residential allotment (community garden) system still existing

in England to this day. Such information was included in his economics essays, published as the book *Fields, Factories and Workshops* in 1899. This book is similar to E. F. Schumacher's famous 1970s classic *Small Is Beautiful*. Its overriding theme is to re-evaluate regional self-sufficiency and community life through taking advantage of appropriately scaled alternative technology and modern communication facilities. His anarchism involves the creation of a more environmentally balanced country-city relationship. Kropotkin envisioned a decentralization of industry complemented by organic and locally sensitive community approaches to land-management and food production, within both urban and rural contexts. Kropotkin's reflections upon alternative technology, decentralization and intensive horticulture were extremely influential in the rise of radical environmentalism in the 1960s and '70s. Colin Ward's annotated and abridged edition of *Fields Factories and Workshops* is a testament to the historical importance of this text and provides a scholarly overview showing how Kropotkin's ideas foreshadowed Geddes' ideas and other well-known non-socialist ventures of his period, such as the Garden City movement.

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Industrial and capitalist approaches to agriculture had led to a belief that such methods were progressive or better, on the grounds of increased efficiency. Around 1850, researchers in Northern Europe began questioning the supposed inefficiency of peasant farming. They concluded that "in terms of energy units used, peasant productivity was greater than that of large capitalist farms."[2] In *Fields, Factories and Workshops*, in addition to his own research, Kropotkin gathered data together from a wealth of similar studies and presented them in a coherent way. Like *Mutual Aid*, this study was a popular success, and Kropotkin is quite well known as a pioneer of ecological-economic arguments favouring intensive, small-scale, organic, market garden approaches to food production based upon energy efficiency.

Some modern readers of *Fields Factories and Workshops* have been dismayed by the extent to which Kropotkin was a technophile with regards to food production. Some of Kropotkin's suggestions, such as "intensive greenhouse potato production," have been justly "criticized on the grounds that more energy units would be required to increase production than would be produced for use."[3] However, *Fields, Factories and Workshops* mustn't be mistaken for something it isn't. The central and overriding purpose of Kropotkin's book was to prove Malthus' over-population theories wrong. This is also a major objective of *Mutual Aid*. The idea that there are "too many people" remains a major preoccupation of the contemporary environmental movement. Kropotkin argued that through the intelligent use of the land in both urban and rural contexts, combined with innovative technologies and practices, it was easily possible to feed an urbanized, industrialized and densely populated country like the UK. Kropotkin's assertion was proven during the second world war, when the isolated island nation successfully fed itself, at least in part, by reintroducing food production to the city.

E. Odum, the famous American marine ecologist and key scientific pioneer of ecosystem theory during the 1950s, regarded Kropotkin as an important historical personality. Odum follows Kropotkin when he calls for moderately sized and self-sufficient cities where "every inhabitant grows at least some of their vegetables in a greenhouse room." Odum also follows Kropotkin when he suggests that we should take a closer look at "traditional mutual aid combinations of agriculture and horticulture involving mixtures of annual, perennial, and tree crops, domestic animals, and fish ponds fed with manure and plant residues."[4]

Kropotkin also believed a communally orientated multi-faceted approach to education, housing, labor, energy and food production could yield significant social as well as ecological benefits. Kropotkin wrote several books on prison issues and viewed the impoverished mass urban environments of state-capitalist-industrial society as a major source of crime. Similarly, Odum questions the wisdom of spending money on prisons without adequately funding "economic services designed to see that the children of the poor do not become criminals."[5] Kropotkin's criminology is, however, more radical and insightful than Odum's general liberal critique. Kropotkin thought that criminal tendencies could only be curbed through the creation of meaningful social environments composed of participatory community structures.

Kropotkin was the first person to contemplate the notion of the green city composed of extended urban neighborhoods communally utilizing intensive horticulture for the production of food from organic wastes and the generation of energy from local or decentralised sources. Cities are responsible for about half of all greenhouse emissions. The conception and construction of sustainable, zero-emission or self-sufficient cities, according to many contemporary environmentalists, is becoming an urgent necessity.

Environmental Geography

During his 40-year exile in England, Kropotkin had to earn a living from his pen. He replaced Huxley as the writer of the Recent Science column for the *Nineteenth Century Journal*, contributing regular popular science articles for nearly a decade (1892-1900). He also produced voluminous articles for three editions of the Encyclopaedia Britannica (1887-1911) on the geography of considerably more than one sixth of the Earth's land area (in essence, the former Soviet Empire and Mongolia).

His broad approach resulted in the longer articles becoming condensed synoptic geographies of vast areas of the Earth. Minimally, each article sketched the distribution of fauna, flora, climate and physiography of each region, combined with an account of the cultural, climatic, ethnic, agricultural and industrial history of the area's human inhabitants. For lesser reference works, such as Chambers, Kropotkin wrote articles covering the whole of Asia (two-fifths of Earth's landmass), as well as European Russia. These reference articles exhibit environmental sensibility by frequently including information on the health of forests, over-exploitation of natural resources and the extinction of cultures, animals and ecosystems because of climatic changes or human action. From the middle of the 19th century, geographers began, to "examine land settlement and use from the aspect of resources, where wilderness was seen as being threatened or endangered."[6]

Kropotkin complains in *Mutual Aid* how it had become nearly impossible to study the social behavior of regional or meta-populations of large mammals. The invention of gunpowder had resulted in "civilization" taking a "300-year hunting trip," leading to the decimation of "animal societies or nations."[7] Destruction of habitat, Kropotkin concluded, had led to changes in animal behavior as their territories were invaded and fragmented by Russian imperialist expansion into Siberia. Kropotkin believed the destruction of animal culture or society at the regional level by

human activity and settlement has resulted in a situation where many previously much-more-social animals had become solitary or exhibited increased aggression and social competition.[8] This is an important theme. H. Melville in *Moby Dick* (which is as much a documentary of whales and whaling as it is a story) tells of huge congregations of whales swimming in vast circles at certain times of the year. Increased competition/aggression has been observed among birds when tall trees that formerly provided ample nesting sites have been felled.

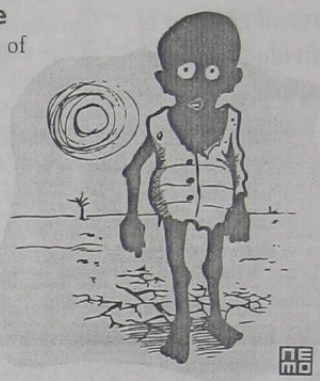
Kropotkin, from almost the very first issue of *The Geographical Journal* (of the Royal Geographical Society in London), continually contributed professional articles about which he had expertise or interest. The most substantial work Kropotkin published in this journal is "The Orography of Asia,"[9] which was later combined with another French article on the Orography of Siberia, and published together in French.[10] In this book, Kropotkin discusses the geological discoveries of his youth and updates them in the light of more recent work by others. Orography is now infrequently used as an equivalent (and archaic) word for geomorphology. But orography for Kropotkin and Reclus was a very broad subject that included all aspects of Alpine life and culture.[11] Mountains are not described in one-dimensional, bare-structural or geological terms. Kropotkin's orography includes detailed assessment of past and present patterns of regional vegetation, climate and distribution and human impacts.

Kropotkin shared this particular interest in alpinism with his American contemporary, Clements. Both ecologists were fascinated by how a lowland species grown in the mountains quickly adapted to closely resemble alpine morphology. The ability to exploit another niche or survive in fluctuating environments by having two or more distinct phenotypes/developmental pathways confers considerable evolutionary advantages. This is most commonly observed in the lowland/marshland and alpine/dry land morphs of the same species. Kropotkin wrote a book upon phenotypic inheritance in the years immediately prior to his return to Russia following the revolution. (He died near Moscow in 1921.) In *Evolution and Environment*, Kropotkin concludes that animals and plants are able to respond to "constantly changing surroundings" and experiment with different niches or climatic regions through utilizing "several developmental lines."[12] Kropotkin summarized research upon adaptive polyphenic plasticity, believing that migration or environmental challenges might favor one developmental pathway over another and result in speciation. The idea that stimulus-dependent phenotypes may be sorted by natural selection was first raised by J. Baldwin in 1896 and developed by C. H. Waddington early in the 20th century.

There is a revival of interest in Waddington's ideas and genetic assimilation, whereby a useful phenotype is replaced by a variation in the genes themselves. Evidence shows that in mammals environmentally induced (e.g., by poor/rich diet, anxiety or chemical exposure), variations of genetic expression may be heritable over many generations by a wide variety and large number of poorly understood epigenetic processes. But animals and plants do not directly adapt to changing environmental conditions, as Kropotkin and many other scientists of his period believed – rather, if they can't migrate to similar ecosystems elsewhere, they generally go extinct. Genomes, it is now thought, remain (dynamically) stable most of the time. But during times of environmental stress, phenotypic variation, or how that DNA is expressed, greatly increases. The majority of heritable epigenetic changes are neutral or pathological. But it is now plausibly suggested that natural selection of particular or entirely novel environmentally induced phenotypes, when occasionally advantageous, may be important and previously overlooked routes to speciation.[13]

Bowler, in his assessment of Kropotkin's defense of the inheritance of acquired characteristics, states that he "exposed the weakness" of his own arguments when he "conceded that alpine species when grown at a lower altitudes soon lose their particular characteristics."[14] Bowler is partially mistaken. Kropotkin also thought that the evolution of phenotypic/developmental plasticity was an important evolutionary development and field of scientific study in its own right. The investigation and acceptance of plasticity, dynamism and change is the vantage point from which Kropotkin builds his philosophical inquiry into nature and society.

Climate Change



Kropotkin published a series of articles in *The Geographical Journal* reviewing geological evidence from around the world of considerable climatic variability in the recent history of Earth.[15] He also produced interesting work upon increasing aridity in Central and N.W. Asia.[16] In *Mutual Aid* Kropotkin suggests mass migration caused by desertification was an important factor in the social evolution of European and Asian civilization:

> The desiccation of North-West Asia goes on a rate which must be measured by centuries instead of by the geological units of time of which we formerly used to speak. ... Numberless traces of post-Pliocene lakes, now disappeared, are found over Central, West and North Asia. Shells of the same species as those now found in the Caspian Sea are found as far East as half-way to Lake Aral and as far North as Kazan. ...
>
> Men of Science have not yet settled upon the cause which some 2,000 years ago drove whole nations from Asia into Europe which put an end to the West Roman Empire. One cause is naturally suggested to the geographer as he contemplates the ruins of populous cities in the deserts of Central Asia, or follows the old beds of rivers now disappeared and the wide outlines of lakes now reduced to the size of mere ponds. It is a quite recent desiccation. Against it man was powerless.[17]

Kropotkin believed that global and regional climate regimes were highly changeable. His practical scientific contribution to our understanding of Earth's paleo-geo-climatology was combined with a revolutionary conceptual outlook that saw natural systems in terms of dynamic instability, continual adaptation and change. This is exactly our modern conception of natural systems, and one that none of Kropotkin's contemporary cofounders of ecology ever articulated.

Animal Ecology and Evolution

Kropotkin is the most important historical figure in the articulation of cooperative, collective or community models of animal life, natural systems and evolutionary processes. *Mutual Aid* was an immediate popular success and has stimulated many evolutionary thinkers to appreciate or re-examine collective dimensions of animal life and evolution. Cooperative models of evolutionary

processes remain controversial. Odum concluded that:

> Studies have shown that contemporary ecological textbooks devote vastly more space to competition and predation in comparison to mutualism. This is despite the fact that there is no evidence that competition is more important than cooperation in the formation and maintenance of bio-systems.[18]

Kropotkin suggested that there were two kinds of natural selection, namely organism vs. organism, which leads to competition, and organism vs. environment, leading to mutualism. To survive, an organism does not compete with its environment as it might with another organism, but must adapt to, or modify, its environment and its community in a cooperative manner.[19]

Kropotkin showed how cooperative economic behavior improved local environments and survival chances of individuals, groups or species...

Kropotkin describes numerous examples of how economic cooperation enhance the survival of the individual, and also, he believed, the group and/or species. A great variety of collective activities concerned with daily survival are not directly linked to reproduction, e.g., collective mechanisms for defense against predators (mobbing in birds), cooperative hunting behaviors (lions), group moderation of the environment (beavers' dams), migration, hibernation (combined heat in numbers), and defense of feeding territories from competitors.

Ecology has traditionally focused upon the "economic behavior of organisms in groups," while "evolutionary theory has focused almost exclusively upon the genealogical products."[20] Kropotkin, a geographer-ecologist, was particularly concerned to show how cooperative economic behavior altered or improved local environments and survival chances of individuals, groups or species. Kropotkin thought that cooperation "favors the development of such habits and characters as ensure the maintenance and further development of the species, together with the greatest amount of welfare and enjoyment of life for the individual, with the least waste of energy."[21]

An adequate appreciation of the economic efficiencies emerging from collective, group or cooperative behavior, Eldredge asserts, is the sort of activity discounted by Dawkins' "reductive gene's-eye"-type theories. Eldredge argues that under the standard neo-Darwinian synthesis, "organisms have come to be regarded, at base, as being concerned exclusively with the maximization of reproductive success." Whereas Darwin had thought "offspring tend to inherit those features that confer relative economic success," the Dawkinites instead insist that "all aspects of living systems are to be understood, ultimately, as an outgrowth of competition for reproductive success and that organisms actively seek to maximise their reproductive success." But, Eldredge continues, Darwin "saw natural selection as a simple accumulator." The Dawkinite vulgarizers of Darwin:

> see economic competition as a direct reflection of real competition for reproductive success. Natural selection is transformed from a passive accumulator to a dynamic process ... responsible at bottom, for the organization of all manner of biotic entities: species, local ecosystems, and most of all, social systems. This reformulation of natural selection into active mode ... in sociobiological literature may be a downright perversion of the genuine evolutionary principle of natural selection.[22]

Kropotkin was particularly interested in the adaptive plastic-

Green Flame notes, *continued from page 33*

Johns Hopkins University Press, 1983, 87. **15.** *The Pampas*, Vol. 3, 1894, 318-321; *New Siberia and the Circumpolar Tertiary Flora*, Vol. 16, 1900, 94-98. **16.** *The Old Beds of the Amu-Daria*, Vol 12, 1898, 306-310; *The Desiccation of Eur-Asia*, Vol. 23, 1904, 721-741. **17.** *Mutual Aid*, 1915, 93. **18.** Odum, *Vignettes*, 174. **19.** Odum, *Ecology and Our Endangered Life-Support System*, Sinauer, 1993, 209. **20.** N. Eldredge & M. Grene, *Interactions: The Biological Context of Social Systems*, 77. **21.** Kropotkin, *Mutual Aid*, 1915, 14. **22.** Eldredge, *Interactions*, 5. **23.** Bowler, *The Eclipse*, 81-2. **24.** Bramwell, 41. **25.** All these thinkers to varying extents included cooperation as a characteristic element of animal behavior and factor of evolution. See Daniel P. Todes, *Darwin Without Malthus: The Struggle for Existence in Russian Evolutionary Thought*, Oxford University Press 1989, Chapters 6, 7 & 8, 105-165. **26.** Kropotkin, quoted in Todes, *Darwin Without Malthus*, 147-9. **27.** Todes, 136. **28.** Kropotkin, *Ethics*, Tudor Publishing, 1947, footnotes pages 35 & 287.

y of animal behavior in social groups. Social animals adaptively modify behavior and transmit this knowledge through imitation or instruction to other members of their social group. Animals that are able to communicate and learn from information provided by others, Kropotkin thought, would be much better able to survive in changing or newly colonized environments. Intelligent animals compensate for their lack of genetic and morphological flexibility by instinctual or behavioral flexibility. The ability to adopt and evolve novel behavior is especially prevalent among highly social species. The social transmission of information between organisms, both within and between generations, is an important and often overlooked factor in evolution.

Plasticity in behavior is the basis of the ability to invent. We often view human historical progress as one of successive technological innovation, but insects are also capable of behavioral inventions that can be passed on. The Cyprus bee, for example, has evolved the unique collective tactic of suffocating an invading hornet by force of numbers. Inheritance is most commonly explained in genetic terms, but in mammals and birds the direct social transmission of behavioral adaptations is equally important.

Kropotkin was interested in the effects of behavioral/developmental plasticity and novelty upon the evolution of species and ecosystems. He believed that migration and subsequent geographical isolation might be a common speciation process (allopatric speciation). But, he also thought that other self-directed changes made by the animal in diet or behavior might result in speciation without prior geographical isolation (sympatric speciation). In all cases, Kropotkin stressed the plasticity of nature at all levels and the active role that organisms play in their own evolution. The hypothesis that novel and self-directed changes in behavior, when selectively advantageous, might initiate speciation was advocated by Baldwin. The leading advocate in Britain was the animal psychologist C. Lloyd Morgan (1852-1936). Kropotkin held a similar position to Morgan, but without the emphasis upon natural selection. Bowler, in his authoritative study of the relevant scientific literature of the period, regards Kropotkin as an innovative and independent proponent of a role for behavioral change in animal evolution. Bowler observes that both Morgan and Kropotkin saw "life as a purposeful activity."[23]

Kropotkin's ethology

Ethology is the study of the interaction and co-evolution of animal behaviors within their natural environments. Ecology was used interchangeably with "ethology in the early 20th century." At this time, ethology, "the idea that animal behavior could be understood by close observation in the wild, was a radical idea."[24] Kropotkin dismissed laboratory approaches to the study of animal behavior and also believed that field experience was sadly lacking among biological researchers.

In his youth, Kropotkin befriended a number of gifted young Russian naturalists, some of whom were members of the expeditionary teams in which he participated. Kropotkin's ethology grew out of the work of Russian naturalists like Severtsov, Menzbir, Brandt and Poliakov.[25] Poliakov and Kropotkin explored Siberia together as members of the same scientific team. Severtsov, like Kropotkin, was a man of action who achieved considerable international scientific fame. Kropotkin befriended Severtsov, describing him as a "great zoologist, a gifted geographer and one of the most intelligent men I ever came across." Severtsov was a pioneering animal ecologist whose interests closely overlapped with those of Kropotkin, particularly with respect to his analysis of migration and "close attention to the fluid relations among organisms." Severtsov's zoogeographical studies also attempted to document and explain the distribution, causes and evolutionary consequences of phenotypic and behavioral plasticity and diversity.[26]

Kropotkin, throughout *Mutual Aid,* champions the need for adventurous field studies in the wilderness and derides the idea that laboratory or desk-top biology is useful in the scientific study of animal behavior. He argues that animals must be observed within their natural environment. Jane Goodall, who undertook pioneering studies of chimps in the jungle, has become a celebrity in our time. By the mid-20th century, the ability to record animals by non-invasive methods, such as cinematography, became available. The size of video equipment continually decreases and we may eventually develop cameras as small as one pixel. This trend is providing new research opportunities for naturalists. Scientists mounting match-sized video cameras on the tail feathers of New Caledonian crows recently discovered how these birds fashion large tools for excavating the forest floor, exploiting an ecological niche and employing tool-making techniques that have never been observed by naturalists before. The modern nature documentary invariably attempts to capture the lives of animals in their natural habitat or home, as Kropotkin had wished.

Kropotkin and Lloyd Morgan believed useful experimental work on animals should be conducted under conditions closely corresponding to their natural habitat. In later editions of his *Animal Behavior,* Morgan, after having read Kropotkin, "conceded the prevalence of mutual aid in nature."[27] Spencer, after considering Kropotkin's ideas, wrote some articles concerning "morality in nature" that were subsequently included in later editions of his *Ethics* and his *Synthetic Philosophy.*[28] But Morgan, Romanes and Spencer, despite modifying their views on animal behavior (ethology) in response to Kropotkin's ideas, never thought that mutualism was a significant factor in the evolution of organisms, animal societies or ecosystems.

The year 2009 began with the Darwin Anniversary celebrations and ended with the United Nations Climate Change Conference at Copenhagen. Kropotkin was a great Darwinist and ecologist, but his broad contribution to the birth of ecology has never been fully documented or analyzed. This sketch provides for the first time a systematic overview of the complete range of his interests, achievements, theories and publications. Kropotkin's pioneering role in the evolution of the philosophy of ecology was all encompassing, substantial and original.

Notes: 1. A. Bramwell, *Ecology in the 20th Century*, Yale University Press, 1989, 13-15. **2.** Bramwell, 66. **3.** Bramwell, 87. **4.** E. Odum, *Ecological Vignettes*, Harwood, 1988, 97-98. **5.** Odum, *Vignettes*, 21. **6.** Bramwell, 15. **7.** Kropotkin, *Mutual Aid*, 1915 popular edition, 37. **8.** *Mutual Aid*, 24 (foxes, wolves and eagles), 37 (weasels). **9.** Kropotkin, *Orography of Asia*, Vol. 23, 1904, 176-207 & 331-361. **10.** Kropotkin, *Orographie de la Siberie avec un apercu de l'orgraphie de l'Asie*, Institut Geographique de Bruxelles, 1904. **11.** See the discussion of Alpinism in Reclus' *Man and Nature* (Jura Media 1995), also his fictional work *The Story of the Mountain* translated by B. Ness and J. Lillie, London: Sampson Low 1881. **12.** Kropotkin, *Evolution and Environment*, Black Rose Books, 1995, 237 & 231. **13.** For a history of the theory of phenotypic inheritance and its relationship to modern research: E. Jablonka & Lamb M., *Epigenetic Inheritance and Evolution,* Oxford University Press, 1995. **14.** Bowler, P., *The Eclipse of Darwinism,*

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