Freedom, Bondage, and the Welfare State

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THE subject of this article (*1*), is not new; it has been treated by many writers since ancient times and is familiar in certain particulars to all zoologists. It pertains to all kinds of animals, including human ones. To review well-known facts, to examine their implications, and to see how they are related to present-day trends and tendencies is, however, distinctly worth while.

One of the objectives of the AAAS, as set forth in its constitution, is "to improve the effectiveness of science in the promotion of human welfare, and to increase public understanding and appreciation of the importance and promise of the methods of science in human progress." Since zoology is concerned with the facts and principles of animal life, information obtained from the study of other animals is applicable to the human species. In the preface to his textbook, *Animal Biology,* the late Robert H. Wolcott stated (*2*),

> Man, as the highest of animals, can learn by the study of animal life the principles of the most effective living. Every problem concerned with living is essentially a biological problem and capable of analysis and solution by the application of biological principles.

Although the interrelations of human society are more complex than those of lower, or at least simpler, creatures, the fundamental and basic tenets of animal associations, those that are consistently manifest in all groups of animals, may properly be considered in respect to the species, *Homo sapiens.* Certain of these associations and their effects appear so constantly, so regularly, and so universally that conclusions based on them may be accepted as valid.

In the last stanza of his poem, *Die Weltweisen,* Schiller declared that the edifice of the world is maintained by the impulses of hunger and love. If we translate this poetic expression into more prosaic and mundane terms, the primary and impelling motives in the lives of animals are those concerned with self-preservation and reproduction. The basic necessities of individual existence and racial preservation are food, shelter, and the opportunity for reproduction. All these perquisites are sometimes included in the term *security,* which has been much emphasized in recent years, and which is connoted in the term *welfare state.* It may be applied to any group of organisms and is not intended to refer merely to political entities, although certain implications may be in order.

All animals seek security, as defined, and in those attempts they relinquish certain of their freedoms and become more or less dependent. Concomitantly, they accept certain hazards associated with the loss of freedom. The advantages obtained are offset by coincident dangers and frequently by disastrous consequences. The surrender of freedom is often, perhaps usually, the result of fear, although frequently it is made on promised alleviation of distressing conditions. But the promised advantages are often illusory, and the bondage imposed as a result of dependency is persistent. As an animal or group becomes dependent, recovery of an independent status becomes increasingly difficult. The welfare state—security with contingent subjection and dependency—offers an easy way of life, but it is a slippery path, which by a slow, gradual process leads to loss of integrity, greater bondage, and eventual degradation.

The most conspicuous examples of the welfare state are found among the sedentary, sessile, and parasitic species. All have descended from free-living, independent ancestors. The sessile and sedentary species are largely marine invertebrates of long, if not distinguished, lineage and include the coelenterates, the tubicolous annelids and mollusks, the priapulids, echiurids, sipunculids, the bryozoans and brachiopods, the barnacles, the phoronids, and the tunicates. These animals have diverse ancestries; indeed, most of the phyla have representatives that have adopted an attached mode of life. The parasites comprise a separate category, and this group contains representatives of most of the phyla, although the great majority are found among the protozoans, worms, and arthropods.

The larval stages of most sessile and sedentary organisms are free-swimming, which provides for dispersal of the species; but, after a period of buffeting by the waves, the larva attaches, undergoes metamorphosis, and settles down to a fixed abode. If the location is covered by sand or silt, the supply of food and oxygen is cut off and the animal, unable to migrate to a more favorable site, is subjected to all the hazards of an uncertain tenure. Moreover, with the assumption of a sessile existence, the original form may be greatly modified. Folds of the body wall often secrete a shell, and the original bilateral symmetry may be replaced by a more or less radial one. The cephalic organs undergo regression, together with the nervous and muscular structures concerned with locomotion. New and adaptive structures are developed which compensate for the degenerative changes and enable the animal to survive in the restricted environment. Unable to move about and obtain food, sessile forms become largely filter-feeders, screening organic matter from the water and transporting it to their mouths by ciliary action.

It is well established that the form of any organism is the result of genetic and environmental factors. Its inherent potentialities are determined by its ancestry, but the actual realization results from the stimuli to which it is subjected during its developmental period, and from its responses to those stimuli. The ultimate form, therefore, is greatly influenced by the physiological activities of the organism during development. Goodrich (*3*) has aptly expressed the idea in his statement:

> An organism is molded as a result of the interaction between the conditions or stimuli which make up its environment and the factors of inheritance. No single part is completely acquired, or due to inheritance alone. Characters are due to responses, and have been made anew at every generation.

There appears to be a popular notion that the trend of evolution is always onward and upward, but zoologists are aware that this is not true. There have probably been as many retrogressive as progressive changes, and variations often occur in divers and sundry directions, although not entirely at random. Much of evolution is directional, and restrictions on the course of hereditary changes are probably to be found in the architecture of the protoplasm and particularly in its protein components. Orthogenetic tendencies are too strong and too numerous to be dismissed as merely fortuitous or incidental occurrences, and the evidence strongly supports the idea that progressive and retrogressive changes follow somewhat prescribed courses. Much of the mystery of ancient times has been dispelled by the physical and chemical discoveries of the last century, and many of the riddles of living processes are being resolved. Consequently, it is reasonable to believe that in nature things do not happen without cause, although the cause may not be apparent. Mutations, changes in the architecture of the protoplasm, accordingly, must be induced, and their origin must lie in responses to physical or chemical changes that affect the inherent structure of the living material. Selection has undoubtedly been a powerful factor in directing the course of surviving mutations, but it is doubtful whether orthoselection alone can explain all the observed facts. Moreover, selection operates in large part through functional activity. As Eimer (*4*) pointed out long ago:

> Every organism owes its peculiar structure essentially to the use of its parts; nay more, owes its continued existence to this exercise and the unceasing action of external stimuli.

Thus, functional activity and responses to stimuli may account for the appearance and development of similar characters in parallel lines; witness the lophophore in many diverse groups of filter-feeding invertebrates. In general, progressive evolutionary changes are correlated with an active, vigorous type of life, whereas the adoption of sluggish, passive, and inert habits leads to regressive changes in the physiology and structure of animals. It is probable that functional changes antedate and direct morphological ones.

The abandonment of freedom for security is well illustrated in many phyla. Leaving the parasitic forms for later consideration, we find that a survey of free-living groups is instructive. The sponges, Parazoa, are not metazoans in the strict sense but colonial organisms, derived from a choanoflagellate ancestry. Flagellate cells produce water currents that traverse the entire structure and bring in essential food and oxygen. Digestion is intracellular, and simple diffusion provides the metabolic requirements of the individual cells. Organ systems as such are not developed. Such an organization is adequate for sponges, but it is quite incapable of supporting more complex and specialized animals. In development, the stomoblastula undergoes inversion, as in *Volvox,* to form the amphiblastula, which becomes attached to the substrate and transforms into the definitive animal. The radial arrangement of parts in simple sponges is obviously correlated with their sessile mode of life.

The coelenterates, according to the concept elaborated by Haeckel, have long been regarded as the simplest and most primitive of the Metazoa, and the developmental sequence—morula, blastula, gastrula—was accepted as the characteristic phylogenetic pathway. Accordingly, all metazoans were derived from a hypothetical gastrulalike ancestor, and the radial type of symmetry was believed to be more primitive and to antedate bilaterality. Acceptance of such a tenet leaves the origin of bilaterality completely obscure and unexplained. Discussing the origin of the Bilateria, Libbie Hyman (*5*) has stated:

> Since the first Metazoa were almost certainly radial animals, the Bilateria must have sprung from a radial ancestor, and there must have been an alteration from radial to bilateral symmetry. This change constitutes a most difficult gap for phylogeneticists to bridge, and various highly speculative conjectures have been made.

Kowalevski (*6*) advanced the hypothesis, elaborated by Lang (7), that the biradial ctenophores serve as a bridge from radial to bilateral types. The idea was based on the morphological similarity between the ctenophores, *Coeloplana* and *Ctenoplana,* and the polyclad turbellarians. But the development of ctenophores is very different from that of the coelenterates; ctenophores have determinate cleavage and mosaic development; the planula stage is lacking, and the larva is a cydippid with ciliated combs. Furthermore, *Coeloplana* and *Ctenoplana* are highly specialized, aberrant ctenophores, a fact that precludes acceptance of the idea that they are intermediate between the coelenterates and truly bilateral animals.

Instead of looking upon the gastrula as a characteristic, phylogenetic stage, Hadzi (*8*) has proposed that the former view be reconsidered. He argued that the coelenterates do not represent a permanent gastrula stage in evolution, that the radially symmetrical structure of the Cnidaria is merely the result of a secondarily acquired habit of sessile life, and that the evolution of the Cnidaria is chiefly regressive. He regarded the planula as the representative of the primitive metazoan and the essentially planulalike Acoela as the simplest of the Turbellaria. He postulated that the Anthozoa, which develop from planula larvae and in some of which (*Edwardsia*) a bilateral symmetry precedes the radial condition, represent the ancestral cnidarians. Attachment and a sessile mode of life was followed by the segregation of the gonads into a separate, sexual medusoid generation, and an alternation of generations became characteristic in hydrozoan coelenterates. The separation of asexual and sexual generations is common in many groups of invertebrates, and the resemblance of the scyphistoma to the polyp has long been recognized.

If the Kowalevski-Lang theory of descent is reversed, if the coelenterates are actually descended from originally bilateral progenitors, our common *Hydra* is not the primitive creature it has been thought, but the end result of simplification—a hydrozoan—which has lost the medusoid generation. The regressive evolution, if it is confirmed, would be the result of attachment and the sessile mode of life. In his text on invertebrate zoology, Carter (*9*) stated:

> All sessile Metazoa except the coelenterates give clear evidence of being descended from free-living ancestors. We do not know whether the coelenterates are also secondarily sessile, but if not, they stand apart from all other invertebrate Metazoa in this respect.

Among the annelids, the tubicolous and burrowing forms comprise a large assemblage of vermiform animals that have sought security by withdrawal into secluded retreats. Comparison with more active, related species shows that the physiological and morphological changes undergone by these tubicolous species are correlated with, and have undoubtedly resulted from, restriction, temporary or permanent, within the confines of a narrow tube or burrow. The body tends to become cylindrical, and the exposed parts develop a radial symmetry. In the terebellids, serpulids, and sabellids, the peristomium forms a collar which bears grooved tentacles that subserve the functions of sensation, respiration, and food collection. Cilia produce water currents which bring food and oxygen, and filter-feeding is typical in this group of organisms. In burrowing forms, *Arenicola* and the earthworm, there is a reduction in cephalic structures, food is taken from the vast amount of soil or detritus that passes through the alimentary canal, and in *Arenicola* the eversible pharynx becomes an efficient organ of locomotion. Among these polychaetes there is progressive loss of metamerism, of parapodia and chaetae; with breakdown of the vascular system and the formation of hemocoelic sinuses; and corresponding modification of the excretory structures. In the archiannelids, originally regarded as primitive, as the name implies, but more probably retrogressive polychaetes, there is undoubted evidence of reduction and simplification. In this group, juvenile polychaete characters are retained, for example, ciliation, epidermal nervous system, and protonephridia. The number of somites, the coelom, and the musculature are reduced, with more or less complete disappearance of the mesenteries and vascular system.

In the more specialized annelids, included in the Gephyrea, which live in the mud and superficially resemble holothurians, the coelom is spacious, but metamerism is partly or completely lost. *Echiurus* has a trochophorelike larva in which several pairs of mesoblastic somites may be recognized, but they undergo regression and are absent in the adult, which is characterized by a large, spatulate prostomium and the presence of a single pair of chaetae. In another echiurid, *Bonellia,* the proboscis of the female is greatly elongated, bifid terminally, and retractile, while the males are dwarf, ciliated creatures, consisting essentially of excretory and reproductive organs, which live parasitically in the segmental organ of the female. The larva has no coelom or segmentation, and the body cavity of the female is formed by the coalescence of spaces in the mesoderm. There is no trace of segmentation in the larva of *Sipunculus*; the adult has no prostomium, but the anterior end of the body is protrusible and retractile. The nephridia are reduced to one pair, and the ventral side of the body is protruded and so elongated that the anus is dorsal and anterior, a condition similar to that in the phoronids and bryozoans.

The Mollusca exhibit great diversity of structure, correlated with their bionomic relations and especially with feeding habits and type of food. The phytophagous species have well-developed radulae, absent in others; the cephalopods and many gastropods are predacious; a few gastropods are parasitic; and the lamellibranchs feed on minute organisms suspended in the water. Except for the cephalopods, most mollusks are sluggish, attached or hidden forms, with obviously regressive modifications. The absence of metamerism, reduction of the coelom to the pericardium and cavities of the gonads, breakdown of the blood vessels and formation of a hemocoele, and the diversity of respiratory organs, ctenidia, mantle or lungs, all testify to the degraded condition of the mollusks. The tubicolous and burrowing species manifest further retrogressive changes, with special adaptations for their restricted mode of life. The lamellibranchs lack eyes, tentacles, and radula; the clam has lost its head; the oyster has lost not only the head but also the foot and the anterior adductor muscle. Cuvier included the bivalves in his group, Acephala, which contained also the brachiopods, barnacles, and tunicates. The term, *headless,* is not inappropriate for these animals, all of which have renounced freedom for security.

The successive stages in the life-history of the sessile crustaceans, notably the barnacles, portray the scenes in the evolutionary drama and exhibit the regressive changes that follow the surrender of freedom. They begin life as free-swimming nauplii, with median eyes, inverted as in the vertebrates, with uniramous antennules and biramous antennae and mandibles. The early molts of the cirripedian larvae result in only slight changes in morphology. A major change then gives rise to a stage in which the animals resemble *Cypris,* a common genus of the class Ostracoda. The body is now enclosed in a bivalve shell, the antennae have disappeared, and the antennules have attachment disks on which cement glands open. In the common barnacles, there are six pairs of thoracic appendages and a small abdomen with four somites. This larva attaches by the disks on the antennules, and metamorphosis is completed. The preoral region enlarges and serves for attachment; the mantle secretes the shell plates; the abdomen disappears; the central nervous system consists of a subesophageal ganglion and separate ganglia for each pair of cirri behind the first; there is no brain; and the body rotates so that the ventral side is exposed. In the reduction and disappearance of the coelom, in the absence of a brain, and in the rotation of the body, so that it comes to occupy a position at right angles to the original antero-posterior axis, the barnacles agree with the bryozoans. This morphological agreement has no genetic basis; it is not homologous but is the end result of an attached mode of life in both groups.

There is a heterogeneous assemblage, often listed as the minor coelomate phyla or as groups of uncertain systematic position. They have persisted, although in diminished numbers, since early geologic eras and may comprise surviving relicts of a primitive, trimetameric, ancestral stock. With the exception of the chaetognaths, they are sessile or sedentary animals and include the bryozoans, brachiopods, and phoronids. In many respects, larvae of the last-named groups resemble those of the echinoderms and prochordates. In all these forms, the coelom, when present, arises as evaginations from the digestive tract and, especially in the early stages, three metameres are often indicated. After attachment of the larvae, profound metamorphic changes replace the original organization with one adapted to the new mode of life. Their systematic relations, therefore, can best be determined by study of their larval stages, but the larvae also are greatly modified; among the Bryozoa, only the larvae of the endoprocts and the shelled Cyphonautes larva of the ectoprocts have functional digestive tracts.

Although the early developmental and larval stages provide the best evidence of systematic relations among animals that are profoundly altered at metamorphosis, the use of larval stages for taxonomic and phylogenetic determinations requires caution and discernment. As was noted by Leuckart more than a century ago, larvae are merely feeding and dispersal stages, adapted to provide for the earlier independence of the progeny, which are thus able immediately to carry on a free-living existence and so to increase the reproductive capacity of the species. This early independence of the young individuals has resulted in the development of adaptive, coenogenetic features, which have no phylogenetic significance. The older idea of recapitulation, that the individual in its life-cycle repeats briefly the ancestral history of the race, has largely been replaced by a more rational and plausible one, namely, that embryos and larvae do not correspond to adult ancestors but to their developmental stages. Accordingly, emphasis has shifted to a study of comparable developmental stages, to axial relations, cleavage patterns, symmetry, and inherent structural details of larval types.

Larvae of related groups show greater resemblance than do the adults, and the resemblances are greater, the earlier the developmental stage. Since larvae become adapted for their own survival and growth, there must be a structural reorganization when the animal transforms to the adult stage which has a different mode of life. The change may be gradual if the larval organs can develop directly into adult ones; otherwise there must be a more or less complete metamorphosis, in which larval structures are resorbed and adult ones are formed by new growth from imaginal buds or other centers of embryonic cells. Such change is witnessed when the bilateral, pelagic larvae of echinoderms attach and transform into radial creatures. In sedentary, mud-living species, the change is less dramatic, and the transformation of the Actinotrocha larva of *Phoronis* recalls the condition in the similarly sedentary sipunculids—enlargement and protrusion of the ventral side of the body until the animal becomes vermiform, with the viscera enclosed in the abdominal extension and the anus turned so far forward that it comes to lie near the mouth.

The agreement in general morphology between the fresh-water ectoprocts and the phoronids and among the Actinotrocha, Tornaria, and echinoderm larvae strongly suggest genetic relationships. These resemblances can be explained on only one of two hypotheses: either (i) parallel evolution—that is, convergence and adaptation to similar habits—has occurred, or (ii) the organisms must have evolved from a group that at some time had larvae of similar structure. Resemblances between these invertebrate larvae are too numerous and too detailed to justify acceptance of the first alternative. On the other hand, if the groups with similar larvae are genetically related, it follows that the adaptive changes in existing groups have resulted from different modes of life, adopted by descendants of the original group. The absence of a coelomic cavity in the endoproct bryozoans may be primitive and they may be related to the lower invertebrates, but their agreement otherwise with the ectoprocts strongly suggests genetic relationship. In endoprocts, the persistence of larval features, the presence of protonephridia, and absence of coelom may indicate pedogenesis, or the coelom may have undergone reduction, as in the archiannelids and mollusks, with ultimate disappearance. The ectoprocts, on the other hand, using the coelomic fluid for operation of the lophophore and tentacles, have retained the body cavity without metamerism, although the excretory organs have been lost.

It is possible that the prochordates may be derived from the same trimetameric stock. In *Balanoglossus* and *Amphioxus*, as in the echinoderms, the coelom arises as enterocoelic pouches which form three primary segments. They are retained throughout life in the Enteropneusta, whereas in the Cephalochordata the second forms the oral somite and the third gives rise to all the postoral mesoderm. *Amphioxus* remains free-swimming, possibly like the chaetognaths as a sexually mature larva, whereas the other prochordates undergo metamorphosis. The Enteropneusta become burrowing, vermiform creatures; whereas the Tunicata comprise a group, predominantly sessile, of retrogressive, sluggish, shapeless forms without coelom, segmentation, or nephridia; with degenerate sense organs and nervous systems; and enclosed in protective tests. In the ascidians, the attached habit results in the formation of a U-shaped digestive tract, a situation analogous to that in *Phoronis* and the sipunculids. So, among the prochordates as in other groups, the sessile habit has led to regressive changes, the original features have been obscured or lost completely, and these animals afford further striking evidence that stepwise loss of freedom has resulted in corresponding retrogression and degeneracy.

Loss of freedom, individual bondage, and the evolution of the welfare state are characteristic features of the social insects. According to Wheeler (*10*), in the last 50 to 100 million years, 24 different societies, each with its own particular features, have arisen in as many different families of insects, representing "Nature's most startling efforts in communal organization." At first glance, the colony appears to be a busy, efficient, happy family, with members contributing maximal effort to the welfare of the group.

Information is probably most complete concerning the common formicid ants and the honeybee. The industry of the ant is proverbial (*11*):

> Go to the ant, thou sluggard; consider her ways and be wise; Which having no guide, overseer or ruler, Provideth her meat in the summer, and gathereth her food in the harvest.

But closer examination of social organization among ants reveals that with the evolution of the "welfare state," there is developed a rigid, rigorous caste system, in which individuals are bound to permanent, monotonous conditions of servitude. The royal individuals perform the sexual, reproductive functions but otherwise lead a life of regal ease, while the other members of the colony belong to one or another of the sterile "worker" castes. There may be various types of workers; some cultivate a fungus, others tend the aphids, "the dairy-cattle of the ants" according to Linnaeus; others are soldiers; and among the honey ants, certain individuals serve as "storage tanks" for honeydew. These latter members are stuffed until their bodies are enormously increased in size, almost spherical; they are quite unable to walk and they hang by their claws from the ceilings of the nest-chambers, giving out nourishment to other members of the colony during periods when food is scarce. Under the surface of the apparently serene tranquility of the ant colony, the most savage and pitiless events are taking place; murder, regicide, pillage, and forays against other colonies in which the adults are killed and the larvae and pupae are carried off to slavery.

The honeybee has been extolled in song and story, even deified, as a virtuous, sedulous, and praiseworthy example of social efficiency. In reality, it is a most pathetic little creature. Restricted during development to such an inadequate diet that its reproductive organs remain rudimentary, without hope of romance or progeny, it burns itself out and dies exhausted after a few weeks of feverish activity, a martyr, and victim of the "welfare state."

But it is in the realm of animal parasites that the most conspicuous results of dependency are encountered. Swellengrebel (*12*) defined a parasite as "an organism wholly dependent on another living organism for its food, its shelter and its reproduction." Note the word *dependent* in the definition. Parasitism is an almost universal phenomenon in the animal kingdom, and it is important to inquire into its origin, extent, and effects. It has long been recognized that parasites have been derived from free-living progenitors. Moreover, it is certain that parasitic lines have developed repeatedly, and at various times, in most of the several phyla, from protozoans to arthropods. In any community, and the earliest ones must have been aquatic, numerous kinds of plants and animals live together, and parasitism is an outgrowth of such association. Animals in the same habitat strive for sustenance, for survival. They seek food, shelter, escape from predators, and opportunity for reproduction.

It may have been accidental or incidental that certain animals found it expedient to attach themselves on or in the bodies of other animals. But acquisition of a host was the first step in the direction of parasitism. In certain instances, fear may have incited the animal to seek shelter; in other instances the secretions or excretions of the host may have afforded nourishment, and hunger may have impelled the association. Or the animal may have been ingested accidentally, and in the digestive tract of the host found conditions suitable for survival. But gradually, the incipient parasite became more and more dependent. When other food sources were insufficient, what would be easier than to feed upon the tissues of the host? The dependent animal is proverbially looking for the easy way. So parasitism involves a gradual and progressive adaptation to a dependent condition on the part of the animal or species that adopts this mode of life. With protection and food supplied abundantly by the host, the parasite enjoys a condition of luxurious idleness. With nothing else to do, its surplus energy finds expression in enormously increased reproduction.

The parasite no longer has to seek food or protection from enemies; it can relax in comfort; the welfare state has been attained. But cessation of an active existence results in characteristic changes in the physiology and morphology of the parasite; the organs that function most vigorously in a free-living existence, which render a species most alert and active, are no longer used and undergo progressive reduction and eventual atrophy. Especially is this true of the sensory and locomotor organs. The parasitic flatworms have lost their cilia; fleas and lice have lost their wings, the scab mites lack eyes and organs of respiration; while the linguatulids are so highly modified that they have lost practically all their primitive characters and superficially resemble tapeworms. With degeneration of the sense organs and muscles, there is a corresponding reduction in the nervous system. As parasitic regression proceeds, one after another of the organ systems suffers a reduction and may eventually disappear. Certain groups, of which the cestodes, acanthocephalans, and monstrillid copepods are conspicuous examples, have lost all traces of an alimentary tract. With the disappearance of the digestive system, the animal has lost the ability to ingest and digest food and is reduced to a saprozoic type of nutrition.

Although less conspicuous, the physiological losses resulting from parasitism are far more important than the morphological ones. The obligate parasite has lost the ability in the absence of other living cells to carry on anabolic phases of metabolism, to synthesize protein, or to grow. It is clear that the enzymes concerned in anabolic processes must be supplied by living cells of the host or other associated organisms. This inability to carry on constructive metabolism, except when supplied with enzymes or coenzymes from extraneous sources, has stymied attempts to culture parasitic organisms *in vitro* and is largely responsible for our present ignorance of the physiology of animal parasites.

While certain organ systems undergo reduction in parasitic species, there is a compensatory increase in reproductive capacity. Luxurious idleness with abundant nourishment supports an active metabolism that finds expression in enormously increased reproductive activity. Protozoa may multiply in the host to reach appalling numbers. A malarial patient with 1 percent of the red cells infected would have approximately 200 million parasites in his body. In metazoan species there is a corresponding overdevelopment of the sexual organs. The number of ova produced by parasitic worms is stupendous. The average daily output of eggs by a mature female of *Ascaris lumbricoides* is about 200,000; of *Ancylostoma duodenale* some 25,000. A specimen of *Fasciolopsis buskii* produces about 25,000 eggs per day and one of *Taenia saginata* about 1 million. This cestode grows 10 to 15 proglottids each day, and each proglottid contains about 100,000 ova. Moreover in parasitic species, new and accessory methods of reproduction increase the number of progeny. Among the Sporozoa, binary fission is replaced by multiple fission; schizogony alternates with sporogony, and the two cycles frequently involve different host species. In the digenetic trematodes, the sexual generation is followed by asexual generations, where polyembryony increases the number of progeny, often several thousandfold. Strobilization in cestodes may be regarded as a form of asexual reproduction. This profuse and unrestrained reproduction is essential, since it is necessary to compensate for the mortality of young stages of the parasites.

Among parasitic species, the offspring, in the form of cysts, or eggs, or larvae, typically emerge from the host and constitute the infective stages that transmit the parasites to new hosts. These dispersal stages, as a rule, are delicate and short lived, and most of them succumb to the hazards of finding the next host. In many instances, not more than one in a million actually succeeds in completing the life-cycle. In a balanced condition of nature, the reproductive capacity of any species just equals the losses occasioned by death. But the parasite is not concerned with the welfare of the offspring. It lives an entirely selfish existence, and in the welfare state the comfort and security of the existing generation is often maintained and enhanced by mortgaging the future of succeeding generations.

It should be remembered that parasites, being wholly dependent, can survive only so long as they can find other organisms to support them. They contribute nothing of value, their effects are definitely deleterious, and the defense mechanisms of the host are eventually mobilized against them. So, despite the apparent ease and luxury of parasitic existence, the probability of success in such a venture is exceedingly small. Such a welfare state exists only for those lucky individuals, the favored few, who are able to cajole or compel others to provide the welfare.

The survey just made shows that throughout the animal kingdom, during human history as recorded in written form and during geologic history as recorded in the evolutionary record, independence, with freedom to explore new vistas, has been the essential condition of progress, whereas the surrender of freedom in an attempt to attain security has led to bondage, regression, and degeneracy. The welfare state offers security to workers on terms of contingent subjection and dependency, but such a social order reduces the individual to abject subservience, and results in the development of a rigid caste system. Dependency and degeneration are cognate phenomena, they go hand in hand; either may be the causative agent, and it is often difficult to determine whether, in any particular instance, creatures became degenerate because they were dependent, or became dependent because they were degenerate. In any event, the well-worn attempt to obtain comfort without effort, to get something for nothing, persists as one of the illusions that in all ages has intrigued and misled the unwary.

References and Notes

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