SYMPOSIUM ON VARIATION XV

THE FAMILY BLATTIDAE: AN EXAMPLE OF "EVOLUTIONARY STASIS"

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Abstract

The cockroach is one of the more popular extant biological organisms available for laboratory experimentation. It is identifiable in Carboniferous rock strata which has an assigned evolutionary age of 280-345 million years. Yet, the cockroach has an alleged phylogeny extending far back into Paleozoic time. This article reviews and critiques current evolutionary research and understanding.

Introduction

Creationists have long recognized that any position contrary to the accepted secular orthodoxy will result in less than complimentary response from evolutionists. A well known university professor has been given credit for one of the more demeaning rejoinders: "Biologist Stephen Jay Gould calls scientific creationism 'an oxymoron—a self-contradicting and meaningless phrase,'" (Fleury, 1987, p. 1513).

The technique of using quotation marks to denote the term scientific creationism as an oxymoron has also been a common evolutionist ploy (i.e., Pastner and Haviland, 1982, p. 1 and Cole, 1983, pp. 23-24).

The charge, however, would seem to look back at evolutionists. An attorney and hopeful evolutionist has noted the preoccupation of mathematical biologist Sewall Wright over living fossils (Macbeth, 1971, p. 121). What, then, is a living fossil? In my opinion, it is an evolutionist oxymoron: ". . . a number of animals, known as 'living fossils,' have persisted essentially unchanged for hundreds of millions of years" (Eldredge, 1975, p. 60).

The quote points up what seems to be an oversight and a possible blunder. Eldredge has excluded one entire biological kingdom from his definition. A Stanford University botanist included as living fossils such ". . . common American trees [as] the sycamore, oak, elm, willow, beach, tulip tree *(Liriodendron)* and others . . ." (Campbell, 1944). A pair of researchers also included the gymnosperm, *Ginkgo biloba* Linnaeus (O'Mally and Kelly, 1988). More significantly, Eldredge's use of quotation marks would seem to lend support to my view of "living fossils."

A Living Fossil by any Other Name . . .

My own research, extensive though not exhaustive, consisting of nearly 100 technical documents, has produced no reference to the cockroach as a living fossil. Such exclusion, however, has not been limited to the cockroach. A zoologist has referred to the platypus as, "A living reminder of an ancient age . . ." (Fleay, 1988, p. 512). A biologist has written of the enigmatic fact, ". . . that sharks have been by-passed by the rest of vertebrate evolution, lingering on as a relic of what was once the dominant vertebrate group in the oceans" (Budker, 1971, p. 21).

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The cockroach has been chosen as the subject of this paper for two reasons. First, the amount of written material on the cockroach is relatively abundant and accessible. Secondly, it qualifies as a living fossil which makes it identifiable as a cockroach for a tremendous period of time by evolutionist reckoning.

A pair of biologists have credited an earlier researcher with placing this insect in the Carboniferous Period noting that it ". . . may be supposed already to have undergone a long period of evolution . . ." (Guthrie and Tindall, 1968, p. 8). An ecologist has charted the Carboniferous from 280-345 million years ago (Futuyma, 1983, p. 73).

How can anyone reasonably discuss the evolution of the cockroach? It would seem evolutionists have made a science of self-delusion. One of the more interesting disclosures contained in a paper described by Guthrie and Tindall (1968, p. 1) as a ". . . classic monograph . . . ," precisely notes one of the reasons for my own incredulity: "The first thing that would strike an observer, looking at the ancient Cockroaches (sic), would be their *general* resemblance to the living" (Miall and Denny, 1886, p. 207). Empirical evidence, in fossil and extant form, would seem to expose as illusory any perceived value of research on the evolution of the cockroach. Yet the authors italicized the term "general." One could speculate at length as to the reason. Perhaps it was a necessary ploy which allowed them to see evolution ". . . unfettered by inconvenient facts" (Dickerson, 1978, p. 85).

McKittrick (1964, p. 117) was able to see two branches in this particular family tree:

> Cockroaches have evolved along two divergent phyletic lineages . . . Members of the two most primitive families, the Cryptocercidae and the Polyphagidae bear certain resemblances to termites and to each other, but both have characteristics unmistakably linking them to the more derivative forms within their respective super-families.

His classic predecessors of nearly eight decades were also able to see evolution with what might be described as a more cautious interpretation:

> We separate the living Cockroaches from other kinds of Orthoptera as a "family" group, and "Cockroaches" have existed since the Coal Measures at least; yet the structure of every one of the older types is really so peculiar that none of

> them can be brought within the limits of the family as it now exists (Miall and Denny, 1886, p. 207).

Such a definitive statement must, of necessity, be based on overwhelming evidence. In fact, the extent of that evidence was revealed: "Three principle differences have been noticed between the ancient and modern forms of Cockroaches . . ." (p. 208). Those differences then, must be profound as suggested:

> . . . similarity of the front and hind wings in the ancient types . . . the same number of principle veins is developed in the front and hind wings of ancient Cockroaches . . . distinction between palaeozoic and modern Cockroaches is found in the veinlets of the anal area (Miall and Denny, 1886, pp. 208, 210).

As noted, an earlier quote of Miall and Denny (1886, p. 207) revealed the use of quotation marks in reference to fossil cockroaches. That would seem to indicate the relationship of ancient to extant cockroaches could only be interpreted nebulously at best. Yet their own description of the differences would seem to be more superficial than significant.

I propose that slight (or even great) differences in wings, veins and veinlets do not constitute evolution of the cockroach in any meaningful sense. Rather, the identification of cockroaches preserved in rock allegedly 300 million years old argues against the evolution of this insect.

Reproduction

McKittrick (1964) has made sexual research observations that seem confusing if not contradictory. He reported (p. 11) that ". . . investigation of the male genitalia and the oviposition behavior proved invaluable for understanding evolution within the suborder . . . *Blattaria.*" However, he acknowledged (p. 33), ". . . remarkably little diversification . . ." of the same characters in Blaberidae. He admitted (p. 99) that,

> The female . . . genital structures . . . of cockroaches . . . have not heretofore been examined from the standpoint of evolutionary trends, nor have the homologies of the various structures been understood previously.

Nevertheless, he was able to write (p. 101) that

> . . . the advent of the genital papilla and the shifting of the common oviduct opening to it from the laterosternal shelf, appears to be a major evolutionary change.

I feel justified in asking, What constitutes variation within kind?

So abundant are some of the fossil cockroaches that Miall and Denny (1886, p. 206) were inspired to write of ". . . the Coal Measures . . . [as] . . . the Age of Cockroaches." The coal measures (the Carboniferous Period) has, as previously noted, an assigned evolutionary age of 280-345 million years (Futuyma, 1983, p. 73). Yet, Guthrie and Tindall (1968, p. 100) and Parker (1984, p. 1186) have pointed out the dubious value of parthenogenetic reproduction in the cockroach. Sexual reproduction, then, would appear to be the only viable choice for perpetuation of the cockroach. Therefore it seems only reasonable that, for a pair of cockroaches to have any chance to cooperate in propagation, they must first locate one another. An entomologist has written what appears a brief how-to manual: "To maximize their efficiency in finding pheromone-emitting females, males should occupy ranges above, over-lapping, or below the females' vertical ranges, depending upon the prevailing atmospheric conditions" (Schal, 1982, p. 1405).

That most probably includes all the possible variations of position. The suggestions do have a distinct postdictive character, based on observation of actual practice. My assessment is reinforced by Schal himself who admitted (p. 1406) that "Intraspecific separation is more difficult to explain. " Undaunted by such unpredicted behavior he ". . . hypothesized that sexual stratification enhanced the efficiency of males in orienting to pheromone-emitting females" (p. 1406). He seems to have come very close to testifying that male cockroaches are able to find mates in spite of themselves. If that be the case, I am at a loss to understand how the cockroach has been able to survive, given the potential for "300 million years" of errant male behavior.

Location of a potential mate, at least with one species of cockroach, would seem to be only half the battle. In addition to a sexual litmus test, there is a role reversal from that reported by Schal. Biologists Moore and Breed (1986, p. 1162), referring to the work of an earlier pair of researchers, noted, "In Nauphoeta cinerea, females are pheromonally attracted to males. " The situation is not necessarily advantageous for any given male, . . . because this species establishes strict linear dominance hierarchies. . . . Females are preferentially attracted to dominant male odours . . ." (p. 1160). As a consequence, the authors felt it important enough to report that, "Copulatory time was significantly shorter for subordinate males and males without status" (p. 1160).

If natural selection is truly a phenomenon of any particular influence, dominant males of the species *Nauphoeta cinerea* should be the rule and subordinate males the exception, given the alleged evolutionary history of the cockroach. This could mean that today we are dealing not really with subordination, but rather with relative levels of dominance. Then again, a relatively low level of dominance could be considered subordinate.

A University of Iowa biologist obviously does not share my reservation with regard to the importance of natural selection on at least one process vital for life: "Sexual selection has led to the evolution of traits whereby males can displace . . . or remove . . . the sperm of previous males" (Woodhead, 1985, p. 159). She also admitted that selection does not seem to work favorably in every case:

> . . . since it always would be advantageous for males to evolve the ability to displace sperm, cases in which sperm mixing occur represent a conflict of male interest" (Woodhead, 1985, p. 159).

Empirical reality is that sperm mixing does occur. Such knowledge may very well fit the definition of what one evolutionist chemist has termed, ". . . inconvenient facts" (Dickerson, 1978, p. 85). Yet, even a conflict of interest can be reconciled to the evolutionary scenario:

> "Large sperm loads may have evolved as a consequence of sperm mixing in some insects. . . . Males that transfer more sperm probably have increased fitness relative to other males (Woodhead, 1985, p. 163).

Symbiotic Research

Symbiosis has been defined as:

> The consorting together or partnership of dissimilar organisms, as of the algae and fungi in lichens. The term ordinarily connotes an association which is mutually advantageous (Funk and Wagnalls, 1968, p. 1270).

Creationists have held up the symbiotic relationship (i.e., cleaning symbiosis) as an example of purposeful design diametrically opposed to the doctrine of evolution (Parker, 1978).

Since every feature of existence can be "explained" on the basis of evolution, it should be no surprise to creationists that an evolutionary interpretation has been appended to symbiosis. A pair of evolutionists has credited Kwang Jeon of the University of Tennessee with discovery of ". . . the evolution of a new organism . . . by symbiosis . . . not over millions of years but in eighteen months" (Sagan and Margulis, 1987, p. 26).

An earlier pair of investigators pointed out a general problem associated with attempts to research one particular symbiotic relationship:

> Because of the intimacy inherent in their dependency, symbiotic organisms resist the separation that is necessary for a critical analysis of the relationship. . . . Among the insects, cockroaches have long been known to harbor bacteria-like objects (bacteroids) thought to be symbiotes . . . The exact nature of the intracellular bodies is still a matter of speculation (Brooks and Richards, 1956, p. 447).

Another five years of research has only superficially addressed the problem of identification: "It is now generally agreed that these symbiotic organisms (bacteroids) are bacteria, although their systematic classification is in doubt" (Bush and Chapman, 1961, p. 267). The one certain fact is, the "bacteroids" are there: "These micro-organisms have been found in every species of cockroach thus far investigated" (Bush and Chapman, 1961, p. 267). Therefore, a rational explanation for their presence must exist:

> The intimate relationship between the egg membrane . . . and the bacteria . . . suggests that active synthesis of one or more substances necessary for egg development is possibly being carried out by the symbiotes (Bush and Chapman, 1961, p. 274).

Such a proposal certainly is a distinct possibility. Yet the reality of the situation with regard to research results is only guesswork.

A team of microbiologists recognized what was viewed as a shortfall in one specific research area: "In general, our overall knowledge of micro-organisms associated with the insect gut, in this case the cockroach gut . . . is fragmentary" (Bracke, et al., 1979, p. 945).

The investigation did provide an answer to one question: "From the present study it was apparent that only the hindgut of the alimentary tract of the cockroach possesses a complex microbial flora" (Bracke, et al., 1979, p. 954). As is often the case with empirical research, for every question answered, another is raised that adds to the pool of the unknown. While this is reason enough to continue research, it does point out the reality with which any researcher must come to terms:

> The only readily recognizable morphotype occurring in chains or filaments was Methanospirillum. . . . Detailed morphological descriptions of other filamentous forms were not tabulated because of the number of different forms noted and because none seemed to possess any unique distinguishing morphological characteristics (Bracke, et al., 1979, p. 954).

Apparently there are times when an abundance of available data for study can be a hindrance rather than a help. Yet, if there is one characteristic that seems to be a consistent part of the evolutionist mind set, it is the ability to impart on the evidence, however meager, a measure of conformity with what has all the indications of a predetermined agenda:

> "Due to the density of aerial forms, coupled with the underlying attached flora, no direct microscopic evidence was obtained to indicate that the microbial filaments were attached to cuticular wall or cuticular filaments. However, there was some indication that they may be in close association with cuticular filaments and with the wall (Bracke, et al., 1979, p. 954).

Nor does the typical evolutionist lack for the courage of his convictions even if those convictions must be stretched to the limits of assumptive optimism:

> Recently it was shown that short-chain acids, e.g., acetic, propionic, and butyric acids, were transported through the gut wall. We speculate that short-chain end products of anaerobic fermentations may be transported and utilized by roaches (Bracke, et al., 1979, p. 955).

It further appears that some evolutionists will make subtle use of comparative data that could well border on the incredible: "Perhaps an analogous situation (with that of the lamb and the calf) occurs in the cockroach, with the microbial flora having some role in the development and physiology of its host" (Bracke, et al., 1979, p. 955).

Nobility of purpose and thirst for knowledge notwithstanding, the research presently under consideration has produced little in the way of tangible results. "The metabolic diversity of the roach-gut flora has yet to be determined. . . . The biochemical microbe-microbe and microbe-host interactions in this complex ecosystem remain to be elucidated'' (Bracke, et al., 1979, p. 955).

Creationists have long insisted that evolution is accepted as a fact in spite of the evidence that refutes it (i.e., Gish, 1978, p. 24). A team of researchers has given credibility to the charge:

> Early cockroaches evolved the cryptic lifestyle and generalized form that have enabled them to survive since the Paleozoic era. Fossil cockroach remains from Upper Carboniferous deposits are grouped in the extant order Blattodae and are thought to have evolved in the Lower Carboniferous or even earlier. These remains show that cockroaches are little changed since then . . . (Wren, et al., 1989, p. 276).

A pair of creationists has given evolutionist George Gaylord Simpson credit for the declaration that evolution is the be-all-end-all explanation for the existence of the universe and everything in it (Whitcomb and Morris, 1961, pp. 442-443). On the microcosmic level, such philosophical predisposition seems to be the conclusion derived from a later investigation:

> The overall inference that can be deduced from these results is that the evolution of the endosymbionts occurred in tandem with the evolution of the hosts, indicating that this symbiotic system has been in existence since before cockroaches evolved the present-day forms on which their taxonomy is based. The demonstrated dependence of the cockroaches on their endosymbiont flora supports this idea, as does the fact that the geographical origins of the species examined are widely disparate (Wren, et al., 1979, p. 280).

A well known evolutionist, perhaps from necessity, has lent his full support to the practice of inferring what one wants empirical data to provide:

> As a paleontologist and evolutionary biologist, my trade is the reconstruction of history. . . . Scientists who study history, particularly an ancient and unobservable history not recorded in human or geological chronicles, must use the inferential rather than experimental methods (Gould, 1978, p. 22).

Such proclamation is based more on convenience than science. The researchers presently considered would seem to have based inference upon the assumption of evolution:

> One of the most intriguing aspects of their physiological makeup is the relationship that cockroaches have established with the bacterium Blatta-bacterium cuenoti . . . [although] the relationship . . . has never been fully explicated.
>
> What is known is that serious deleterious effects are caused in cockroaches by destruction of the endosymbiont bacteria. This finding has led to the hypothesis that the microorganisms and their hosts are engaged in a mutualistic relationship (Wren, et al., 1989, p. 276).

Based on the research, the hypothesis would seem to be empirically sound. What I cannot understand is how the investigators can validly proceed from the obvious endosymbiotic relationship to tandem evolution. Perhaps the key word is validly.

Cockroaches and Termites

Among the recent writers of more generalized literature, there is a consensus that the cockroach and termite have a shared evolutionary history (McKittrick, 1964, p. 98; Guthrie and Tindall, 1968, p. 3 and Bell, 1981, p. 1). A more current researcher has offered a reason for such opinion:

> Living species of the cockroach family Cryptocercidae have intestinal symbionts that are cogeneric with some of the gut protozoa found in Isoptera. Presence of such closely related symbionts in cryptocercids and in termites has been frequently interpreted as a uniquely derived homologous character shared between the two xylophagous groups (Thorne, 1990, p. 37).

Such reading of the evidence, however, has been challenged: "This may not be the most parsimonious interpretation" (Thorne, 1990, p. 37). The reason for caution was explained as what has apparently been seen as a contradiction with regard to equally valid evidence:

> One complication is that if there was a common ancestor with the symbionts, then that implies that there was a secondary loss of the gut fauna and coincident change in diet and habits, in all other roaches (Thorne, 1990, p. 37).

It has been my experience that the typical evolutionist is reluctant to denounce the research labors of another. Perhaps the following testimony was an attempt on the part of the later investigator to disagree diplomatically:

> It is fairly certain that some of the intestinal protozoa found in the termites and in *Cryptocercus* are derived from a common ancestral flagellate. The protozoa are morphologically very similar, and immunological characterizations of the protozoa suggest that the symbionts of the two hosts are related (Thorne, 1990, p. 37).

Yet, the newer proposal still stands in opposition to the older: "It is possible, however, that these flagellates were not inherited by *Cryptocercus* and termites via a common ancestral host, which is the general assumption" (Thorne, 1990, p. 37).

The relationship has been touted as an observational fact: "Termites and wood-dwelling cockroaches depend on symbiotic intestinal fauna for aid in digestion of cellulose" (Thorne, 1990, p. 37). The need for explanation was proposed with greater prudence:

> By occasionally killing and consuming an intruder from the other group, gut protozoa could have been acquired and exchanged between termites and *Cryptocercus* or their ancestors, under natural conditions and before the life histories of the protozoa became specialized within the host orders (Thorne, 1990, p. 37).

Rare indeed is the research proposition that is without contestation. The present offering was no exception:

> Suggestions of natural transfaunation have been repeatedly discussed, however, because of various life-history and morphological differences between flagellates found in Isoptera and *Cryptocercus* (Thorne, 1990, p. 38).

The research arena has, however, proved a fertile ground for point-counterpoint exchanges: ". . . differences in morphology and life history between protozoa found in living termites and in *Cryptocercus* reveal nothing about the characters of ancestral flagellates" (Thorne, 1990, p. 38).

Perhaps, laboratory testing that tends to lend support to an hypothesis, bears out the adage that 'the best offense is a good defense':

> Successful protozoa transfaunation between *Cryptocercus* and *Zootermopsis* has been repeatedly demonstrated under experimental conditions . . . All previous research suggests that the consumption of gut contents from recently dead individuals does result in successful symbiont transfaunation within termites . . . or between *Cryptocercus* and *Zootermopsis* (Thorne, 1990, p. 39).

Yet, ensuing testimony would seem to be an admission that experimentation was of little or no practical value:

> ". . . documented presence or absence of transferred live protozoa to modern insects following consumption of the other host is irrelevant to the proposed theory. Survivorship of protozoa that may have been transferred between the ancestral groups millions of years ago is pertinent, but impossible to assess (Thorne, 1990, p. 40).

The last quoted statement is applicable to all attempts to investigate evolution. There is no evolution, in any meaningful sense of the term (i. e., transformation of species), taking place today. Therefore, evolution is historical and hence, "impossible to assess." Such admission, however, did not prevent a conclusion which is partially assumptive and partially careful testimony: "Cryptocercidae are clearly primitive roaches, but it is most likely that the family is a sister group to other cockroach taxa rather than a sister group to modern termites" (Thorne, 1990, p. 40).

Current Research

Cockroach experimentation has covered such diverse topics as the implantation of female germ cells (oocytes) into males (Mundall, et al., 1979) and the study of water loss in cockroach integument (Machin, et al., 1986). The topic which has received the most attention (35%), nearly twice that of the next most frequent, is the neurone: "A nerve cell with all its processes and extensions" (Funk and Wagnalls, 1968, p. 853).

Some of that activity has been concentrated on micro-electrode recordings of neurones in the cockroach brain and eyes which are interrelated (Mizunami and Tateda, 1986). Brain research has included injection of certain neurones with octopamine (Schofield and Treherne, 1986), injection with current (Christensen, et al., 1988) and injection with potassium (Schofield, 1990). Research on the eyes included illumination and other sensory stimuli (Ohyama and Toh, 1986) and illumination in a variety of ionic solutions (Mizunami and Tateda, 1986; Mizunami, et al., 1987).

A pair of researchers made readers aware of a pioneering spirit in their work:

> The blood-brain barrier of insects has been suggested by several investigations to be formed chiefly by the superficial layer of neuroglia of the central nervous system, the perineurium. . . . Hormonal control of the perineurium or other neuroglia in insects has never been studied (Schofield and Treherne, 1986, p. 423).

The procedure by which the desired information would hopefully be obtained was outlined:

> The hypothesis that external application of . . . octopamine to the cockroach nervous system lowers the [sodium] permeability of the blood-brain barrier . . . was tested by examining the effect of such exposure upon the interstitially recorded trans-perineurial potential (Schofield and Treherne, 1986, p. 425).

One result was conjectural:

> An effect of octopamine upon the basolateral membrane (i. e., depolarization of . . . e.m.f., together with some reduction in . . . resistance) could easily be accompanied by an effect upon some other parameter of the perineurium (Schofield and Treherne, 1986, pp. 434, 435).

Another was more conclusive: "Octopamine has been shown in preliminary experiments to cause a reduction in the net [potassium] permeability of the perineurium (Schofield and Treherne, 1986, p. 435).

A team of insect physiologists chose to concentrate their efforts on an area which would seem to have been virtually ignored: ". . . little is known about the evolution of excitability or the types and distribution of voltage-sensitive ion channels in the developing insect neurone" (Christensen, et al., 1988, p. 194). Methodology was briefly noted: "One approach to the study of the development of excitability is to investigate embryonic cells during maturation in culture" (Christensen, et al., 1988, p. 194). Acknowledgement was made of procedural restriction: ". . . we can understand the excitable properties of the neurone only by isolation of the underlying conductance changes into their individual components" (Christensen, et al., 1988, p. 194).

Limitation posed by laboratory procedure was explained:

> Although some information about excitability can be obtained using current-clamp techniques, a thorough analysis of the membrane currents that underlie the voltage changes . . . requires the use of voltage-clamp technique (Christensen, et al., 1988, p. 194).

The results of the technique employed were positive:

> The voltage responses during depolarizing and hyperpolarizing current steps demonstrate the rectifying properties of these cultured neurones . . . most of the voltage change during depolarization results from a voltage-dependent increase in membrane conductance to potassium (Christensen, et al., 1988, p. 197).

Most of what was learned in the forgoing exercise would seem to be less than inspirational:

> Investigation of neuronal excitability in the intact insect nervous system has suggested that the cell membrane includes voltage-gated sodium, calcium

> and potassium channels . . . In this respect, cultured cockroach neurones do not appear to differ from their intact counterparts . . . action potentials associated with activation of voltage-sensitive calcium channels can be evoked, at least under the special conditions where barium replaces calcium and the outward rectification is blocked (Christensen, et al., 1988, p. 210).

Information remained obscure:

> Whether these calcium channels are important for regenerative activity or to serve as a means of calcium entry for activating other channels, for example a calcium-activated potassium channel, remains to be determined (Christensen, et al., 1988, p. 210).

The earlier admission of knowledge gaps regarding ". . . the evolution of excitability . . ." stands.

Ocellar System

A pair of biologists published some well known facts of a generalized nature based on empirical research:

> Many insects possess two or three dorsal ocelli in addition to the paired compound eyes. The dorsal ocellus is characterized by a high convergent ratio of many retinular axons upon several thick second-order neurones in the posterior region of the ocellus (Ohyama and Toh, 1986, p. 405).

However, it was also admitted that the accumulation of generalized observational data had not provided certain specific knowledge which was considered important: ". . . our knowledge about how information is processed in the ocellar system is limited" (Ohyama and Toh, 1986, p. 405).

The main focus of research activity was described for one of the more popular species of cockroach:

> . . . several thin processes, which respond to various sensory stimuli other than ocellar illumination, are included in the Periplaneta (americana) ocellar nerve and are referred to here as small multimodal ocellar interneurones (SM-neurones) (Ohyama and Toh, 1986, p. 405).

A listing was provided of the other excitation modes:

> The SM-neurones respond with spike discharges to the following stimuli; illumination to compound eyes, movement of antennae including tactile stimuli and air puffs to antennae, air puffs to cerci, vibration to legs, and spontaneous/forced wing beats (Ohyama and Toh, 1986, p. 405).

A brief review of laboratory test procedure was provided: "Recordings from suction electrodes attached to a mid-region of the ocellar nerve revealed spikes originating in more than two SM-neurones" (Ohyama and Toh, 1986, p. 405). Yet, all the described flurry of activity resulted in proposals that appear more speculative than substantive.

> The SM-neurones found in this study may be homologous to the ocellar efferent fibres of dragonglies . . . The functional role of SM-neurones in the ocellar system is not properly known, because the ocellar contribution to behavior itself is not known in Periplaneta. However, some possible function may be inferred by referring to ocellar function reported in other insects (Ohyama and Toh, 1986, p. 408).

A team of biologists undertook the investigation of certain nerve cell processes in an insect often used in research: "The ionic basis of the action potential in the large second-order neurones (L-neurones) of the ocellus of the cockroach, *Periplaneta americana,* was studied" (Mizunami, et al., 1987, p. 259). The methodology was briefly described: "The ionic mechanism of the action potential was studied by changing the ionic environment . . ." (Mizunami, et al., 1987, p. 261).

Some of the accumulated data, which was based on observation was presented:

> The ocellus of the cockroach contains about 10,000 photoreceptors which have synapses onto four large second-order neurones, the L-neurones. The L-neurones extend dendritic branches into the ocellus, and their axons project into the ocellar tract neuropile of the brain, through the ocellar nerve. In the ocellar tract neuropile, L-neurones make synaptic contacts with the higher-order neurones (Mizunami, et al., 1987, p. 261).

As a result of this research, a conclusion was drawn: "The action potential of the cockroach L-neurone originates in the ocellar tract of the brain" (Mizunami, et al., 1987, p. 270). The investigation additionally produced useful information on the other side of the ledger, though apparently not as definitively:

> The results also suggest that under normal conditions sodium ions have little role in generating the action potential since treatment with sodium-free saline did not affect the size or shape of the action potential (Mizunami, et al., 1987, p. 269).

While preparing this portion of the paper, I could not dismiss the feeling that the activity described had more to do with the operation of electrical measurement equipment than neurological research on the cockroach. One researcher even provided evidence tending to support this:

> Potentials recorded from the perineurium were interpreted in terms of an electrical model. . . . In electrical terms, the circuit consists of a loop composed of the shunt and the two membranes (Schofield, 1990, p. 338).

Conclusions

If research is to have any particular value the result should be an increase in the useful knowledge of the subject under study. Even if the effort is unsuccessful, such intent would constitute justification for the particular undertaking. The key word is *useful.* I am unable to discern any useful knowledge which has been gleaned from the research described in this paper. On the other side, I may be making this more complicated than it actually is. Perhaps I should not look beyond the pressure to be published.

Forced evolutionary interpretation of empirical evidence does not give proper weight to other possible explanations. The cockroach is recognizable as an extant biological organism. Described superficial differences notwithstanding, it is identifiable as a fossil form in sediment alleged to be between 280 and 345 million years old. Therefore, evolution is not the best explanation for the existence of this biological organism.

Is there other motivation for so much research on the cockroach? A biologist has promoted one particular species on the dual bases of observational variety and economics:

> The Maderia cockroach, *Leucophaea maderae,* has been used extensively . . . in the illustration of biological principles. A wide range of experiments, including both ecological and biochemical approaches, are possible with this insect. . . . The use of this animal is particularly effective in crowded, low-budget biology courses . . . (Yurkiewicz, 1970, p. 39).

A pair of biologists provided a more generalized purpose and were far less kind: "The advantage of cockroaches as laboratory animals is that they survive in spite of the technical assistance available in some laboratories!" (Guthrie and Tindall, 1968, p. 17).

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QUOTE

(Jay) Gould was thus a complex figure. In his private life he adhered to a Victorian code of conduct that was already crumbling when he died in 1892. Commerce was pursued in a laissez-faire marketplace where social Darwinism reigned supreme. At home, life, unfolded within a thick web of Christian morals and bourgeois propriety. While future generations would find the latter combination reeking of hypocrisy, it was the accepted ethical standard of Gould's day. The free market would create and diffuse wealth throughout society, while men saved their souls in private.

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