A DESERT MILLIPEDE: EVOLUTION OR DESIGN?—AN INTRODUCTION

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Abstract

A survey of some of the interesting functions, structure and behavior of a desert millipede, ***Orthoporus ornatus,*** *is presented. Times of surface activity, defensive mechanism, food preference and locomotion are discussed. The origin of these characteristics is best philosophically explained within a design framework.*

General Information-Millipedes

Millipedes are in the class of animals called Myriapods (many-legged). They are distinguished from other Myriapoda by the presence on most of their ring-like body segments of two pairs of legs, thus the creatures are referred to technically as Diplopoda (double-legged) [Tiegs, 1957, p. 502; Gertsch, 1990, p. 249]. Millipedes have long segmented bodies like those of caterpillars with the number of legs ranging from 20 to over 200 (Holland, 1990, p. 129). Placed in the phylum Arthropoda, class Diplopoda, the animals have bodies composed of a head and elongated trunk with leg-bearing segments (Barnes, 1968, p. 551). The length of the different species varies from less than 0.1 to 11 inches (Holland, 1990, p. 129).

The head portion of a millipede has short antennae. Generally the creatures are light-shy but most have ocelli (eyespots) (Barnes, 1968, p. 551; Holland, 1990, p. 129; Burton and Burton, 1989, p. 1613). However the Juliformia order of millipedes usually have eyes (Barnes, 1968, p. 558). Millipedes have chewing mouthparts with two pairs of jaws (Smith, 1982, p. 27: Blower, 1985, p. 3). Most species of millipedes eat decaying plant matter** but they will eat living vegetation also. The animals are generally colored black or brown, yet some are red, orange or mottled (Holland, 1990, p. 129) with a luminous species *(Luminodesnus sequoiae)* noted in California (Buchsbaum, et al., 1987, p. 404).

There are 10,000 described species placed in 10 orders widely distributed in both temperate and tropical regions and it has been estimated that possibly there remains 70,000 undescribed or undiscovered species (Barnes, 1968, p. 551; Barnes, et al., 1988, p. 240; Blower, 1985, p. 1). These secretive egg-laying animals normally live under rocks and wood and in soil and humus. See Figure 1 for sketches of various types of millipedes.

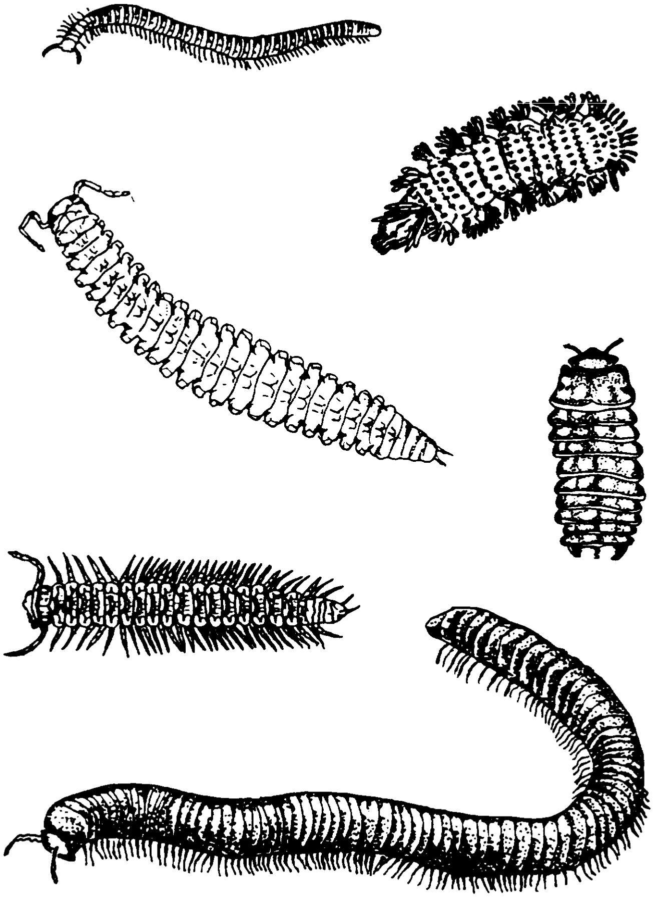

Figure 1. Representations of several types of millipedes (after Barnes, et al., 1988; Smith, 1982). Drawings by Randall R. Smith

Observations of a Desert Millipede

Geological expeditions were-made to the Big Bend National Park in May 1988 and July 1990. Likewise field work was performed in and around Grand Canyon National Park in June 1990. All trips were under the auspicies of the Research Committee of the Creation Research Society. It had rained in these areas immediately before the field work and in July 1990 scattered continued in the area while the studies were showers in progress.

At Big Bend the desert millipede is identified as *Orthoporus ornatus* (Girard) [Wauer, 1980, p. 106]. Many were observed throughout the Chihuahua Desert region of the Park, May 21-24, 1988 and July 16-19, 1990. The millipedes can be seen crossing the major roads in the Park after rains and visitors often joke about the evasion tactics taken by automobiles to avoid crushing the moving animals.

On June 11, 1990 three specimens, likely *O. ornatus,* were seen near the road from Peach Springs, Arizona to the Colorado River (the only place one can drive to the Colorado River in the Grand Canyon) down Peach Springs Canyon or Wash (Hamblin and Rigby, 1969, pp. 98-103). The Hualapai Indian Nation maintains the road and permits to travel on it must be purchased at the Hualapai Nation Office at Peach Springs or the service station across the street in the event that the office is closed.

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**Certain species of millipedes are predatory (Holland, 1990, p. 129) and some tropical varieties eat dead insects (Buchsbaum, et al., 1987, p. 404).

Two of the specimenns were seen while studying a geologic formation about 1-2 miles from where Diamond Creek enters the Colorado River (Mile 225.6) at Peach Springs Canyon (Figures 2 and 3). The other millipede was seen traveling across the bank of the Colorado River about 50 feet south from where Diamond Creek enters the river (Figures 4 and 5).

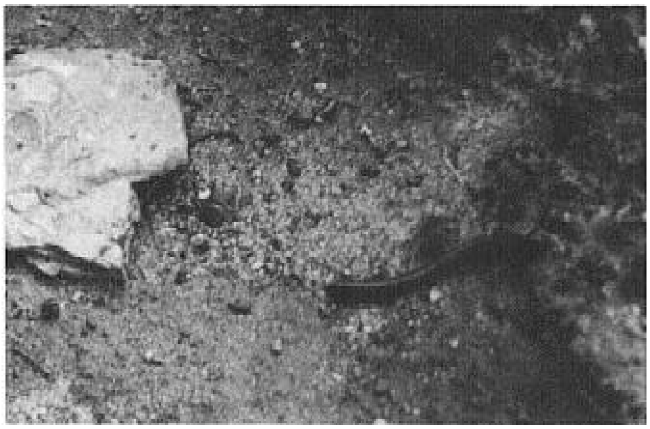


Figure 2. Millipede, likely *O. ornatus*, seen in Peach Springs Canyon, June 1990.

Range and Habitat

Causey (1975) discussed the locations where the spirostreptid millipede O. *ornatus* has been found in the southwestern United States and northern Mexico. Both Causey (1975, p. 3) and Crawford, et al. (1987, p. 65) showed the range of the animal as far south into Mexico as a latitude of 20°N. The known locations of the species as of 1975 in the southwestern United States are shown in Figure 6. The millipede is widely distributed in the Chihuahua and Sonoran deserts, with population densities estimated at about 600/acre (Wallwork, 1982, p. 40; MacMahon, 1987, p. 521).

Considering this wide distribution, *O. ornatus* obviously is able to survive several different environments. Generally it lives in semi-arid to arid climates (Crawford, et al., 1987, p. 65). Also the amount and timing of the rainfalls, vital for the active period of its life, vary throughout its range. Crawford, et al. (1987, p. 67) outlined the regional environments of the millipede:

Figure 3. Typical terrain seen in the lower portion of Peach Springs Canyon where millipedes were found.

> Topographies, soils and vegetation in *O. ornatus* habitats . . . are by no means equivalent throughout the species range, although combinations of these habitat features must provide populations with adequate shelter if drought, heat and cold are to be survived. Shelter often takes the form of rodent burrows and ant nests, . . . large surface stones and rock outcrops. Basalt-flow habitats confer excellent shelter to the north . . . . as do the lower slopes and terraces of large riparian channels such as those created by the Colorado River in the Grand Canyon. . . . Such places probably constitute warm, post-Pleistocene refugia ('thermal islands' in effect) separated by terrain in which soils often freeze during winter. In contrast, populations to the south are commonly distributed over broad, flat expanses having surfaces of desert pavement. . . .
>
> Sandy loam aridosols are probably the most characteristic soils of *O. ornatus* habitats. Powdery grey loam, comparatively heavy in clays, characterizes a flood plain used extensively by *O. ornatus* in western Texas.

Figure 4. Cover Photograph.

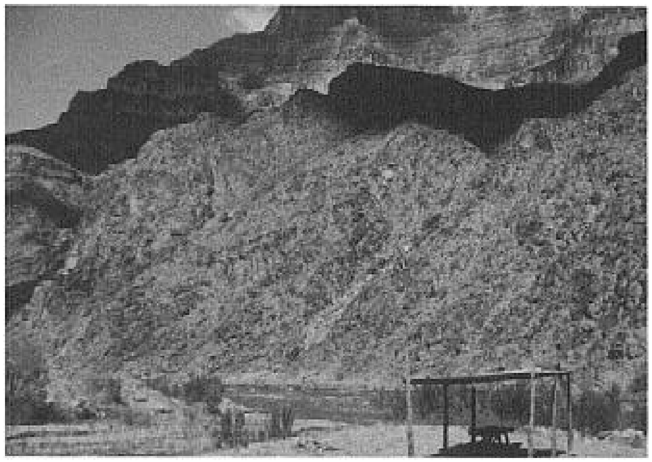


Figure 5. Colorado River in Grand Canyon where Diamond Creek flows into the river. Millipede in Figure 4 was found in this area. Diamond Creek can be seen in the left foreground and picnic table constructed by Hualapai Indian Nation is seen in the right foreground. Photograph by Glen W. Wolfrom

Times of Surface Activity

Most millipedes live in mesic environments (balanced supply of moisture), therefore one can find the animals by overturning stones, decaying wood, etc. anytime the weather is sufficiently warm. Likewise they typically avoid light. However *O. ornatus* is active on the soil during *daylight* yet only for a brief period during the rainy season, usually after summer rains (Wallwork, 1982, p. 40; Wauer, 1980, p. 107). As Crawford and Wooten (1973, p. 21) stated:

> Perhaps the most striking feature of this animal's life is that it appears to feed for a very limited time of the year, unlike millipedes living in forest litter . . . responsiveness to a reasonably predictable rainfall pattern during the warmer parts of the year has obviously evolved in this species. Early rains during the late spring appear to trigger

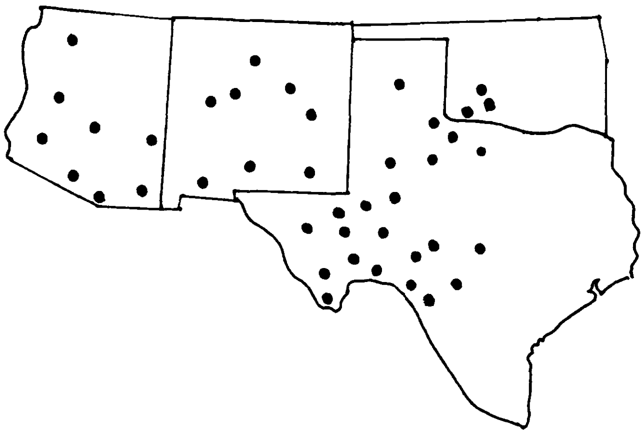


Figure 6. Range of *O. ornatus* in southwestern United States (after Causey, 1975). Drawing by Randall R. Smith

> an annual molt and to arouse the otherwise quiescent millipedes to a state allowing later surface foraging.

Also late rains can cause surface activity of this species.

Wallwork (1982, p. 41) explained this behavior as follows:

> In hot deserts, species that restrict their periods of surface activity to times of the year when they would experience the least environmental stress would have a selective advantage. This is the rainy season . . . , the species that have become established in hot deserts are those that are surface-active at this time.

Some other factors that enable *O. ornatus* to survive the hostile environment of the desert will be discussed later.

The main point of this section is that the seemingly startling behavior of surface activity of the millipede in "broad daylight" in the hot times of the year in the desert has been verified during three particular expeditions by the authors. The sightings have occurred as mentioned earlier after rains in the hotter seasons in the desert region of Big Bend National Park and in lower slopes of the Grand Canyon area after considerable rain two days earlier.

The three millipedes sighted on June 11, 1990 were most probably foraging; one was seen moving on the terrain in Peach Springs Canyon, another seen within 50 ft. of the former, moving across the spines of a barrel cactus, *Ferrocactus* sp. (Figure 7) approximately six inches above ground level. The final sighting that day was made of a specimen on the banks of the Colorado River apparently moving toward shelter in the rock debris in that location (Figure 4).

Many of the millipedes seen in May 1988 at Big Bend were in the Dog Canyon area for much time was spent in investigating the geology of that place. Others were seen in the desert near Boquillas Canyon, Santa Elena Canyon and near Cerro Castellan. Several were observed on the banks of the Rio Grande in Madera Canyon west of Lajitas, Texas along highway 170.

As previously noted, many millipedes could be seen crossing the roads at Big Bend National Park during July 1990 but most of them were seen in and around the Javelina Formation at the northwestern end of the Park since much of the field work was done in that region. Others were seen below Reed Plateau west of the Park near Terlingua, Texas. The animals were observed eating dead vegetation on the soil surface and several were found on creosote bushes *(Larrea tridentata)*. One was foraging on the decayed lower areas of an unidentified cactus plant.

Defense Mechanism

One might wonder if this relatively large millipede does not place itself at risk when it moves on the ground in the daytime. It could be imagined that many birds, rodents and lizards would enjoy a meal of *O. ornatus*. Such highly visible foraging could not be missed by sharp-eyed predators.

Wallwork (1982, p. 42) suggested:

> Daytime surface activity may also serve to lessen predation pressure since carnivorous arthropods, notably centipedes, scorpions and their relatives, are nocturnal in hot deserts.

These millipedes have defense mechanisms that can repel many daytime predators. When disturbed or threatened, the desert millipede rolls up in a spiral (Figure 8). The hard exoskeleton facing a predator may offer discouragement. Also *O. ornatus* secretes or oozes a noxious liquid substance from a set of interior glands through small pores (Figure 9) serially arranged on both sides of a trunk segment along its length. The glands are found in all segments except the first five and the last one. A representation of the structure of the glandular device likely present in *O. ornatus* is shown in Figure 10.* When prodded (Eisner,

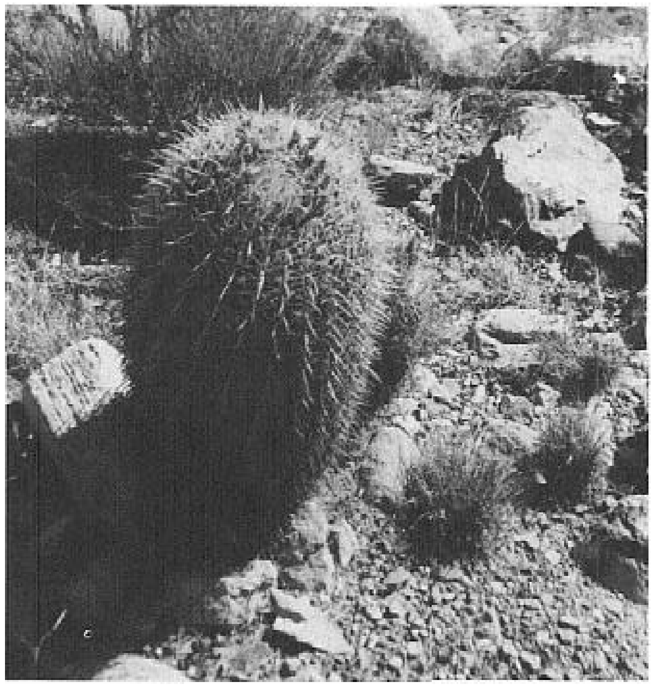


Figure 7. Barrel cactus in Peach Springs Canyon similar to the one on which a millipede was moving across the spines.

***The exoskeleton of the millipede shown in Figure 15 had pores that were clogged with a black mass that could not be removed by extended soaking in acetone or ethyl alcohol.**

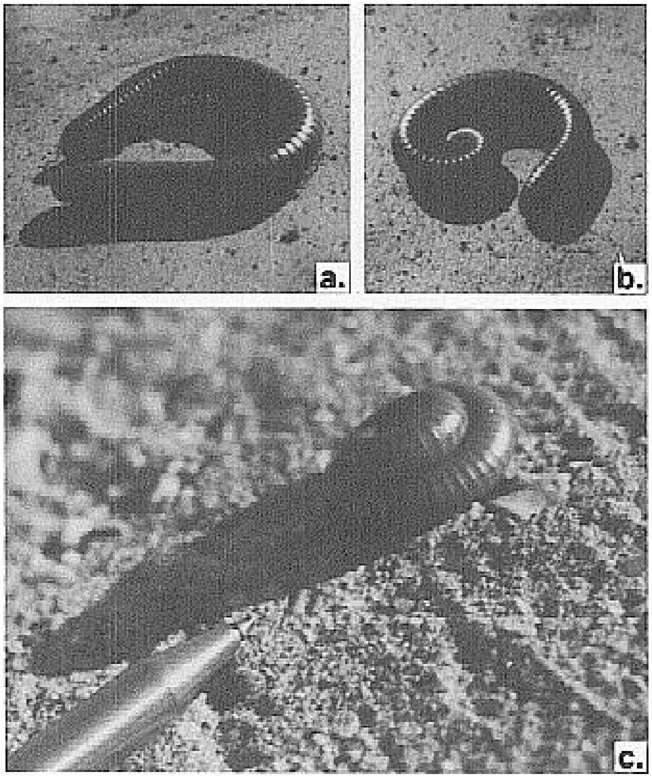


Figure 8. When a millipede senses danger or is disturbed, it will assume a defensive coil: (a) Millipede begins to coil; (b) Another millipede in the process of coiling; (c) Completely coiled millipede. Photographs by George F. Howe

et al., 1978, p. 49), a millipede discharges its secretion from the glands ***in the area*** where it is disturbed. The protective fluid apparently is stored in a spherical reservoir in millipedes of order Spirostreptida, transported through a slender tube to a valve which is opened by a muscle attached to the wall of a segment. Eisner et al. (1978, p. 44) assumed that the liquid discharge is accomplished by muscle contraction opening the valve along with simultaneous compression of the reservoir sac. Eisner and Meinwald (1966, p. 1344-45) claimed that arthropods can release fluid from the glands that are nearest to the site of a predator's attack increasing the efficiency of the defensive weapon; also see Eisner et al. (1978, pp. 58, 59). Considering the amount that is discharged at and near the location of the disturbance, an intricate sensing and control system must be required.

The defensive liquid released by *O. ornatus* has been found to contain 2-methyl-1,4 benzoquinone and 2-methyl-3-methoxy-l,4-benzoquinone (Figure 11) [Eisner et al., 1965, pp. 247-48; Eisner et al., 1978, pp. 45-46, 52]. Benzoquinones appear to act as repellents or irritants to potential predators. Once released, the

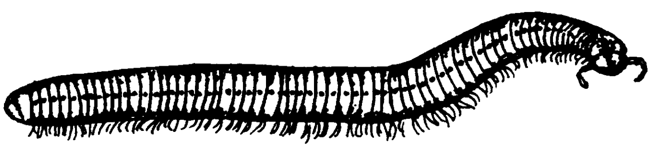


Figure 9. Artist's representation of *O. ornatus* showing approximate location of pores along trunk where defensive chemical substance is emitted. Drawing by Randall R. Smith

liquid may coat the millipede protecting it against an immediate repeated attack. Eisner and his colleagues placed amounts of benzoquinones near or on potential predators such as birds, ants, spiders and mice. These animals reacted to the vapors and / or liquid by leaving the location of application if the fluid had been placed near them. If some portion of their exterior surface was contacted by the liquid, the potential predators immediately attempted to clean themselves to remove the noxious substance. Even frogs have been noted to reject millipedes in a laboratory situation after seizing them. Benzoquinones are also toxic. If a millipede is ingested by a predator rapidly before the presence of the defensive secretion can be detected, it could prove to be fatal. *O. ornatus* indeed possesses a fantastic defensive system to allow it to forage in the daylight hours.

Like all systems in nature it is not 100% effective. There are predators that can overcome or are not affected by the defense secretions emitted by millipedes (Eisner et al., 1978, pp. 63-65). Crawford, et al. (1987, pp. 81, 82) contended that lizards, shrikes and rodents cause the most trouble for *O. ornatus.* It is known that larvae of *Zarhippus* spp. (glowworm beetle) act as predators on the desert millipede. It is not known if gut parasites do any damage to the millipede or not. Do violent rains on desert terrains cause the death of many millipedes? See Figure 12 for the remains of a millipede.

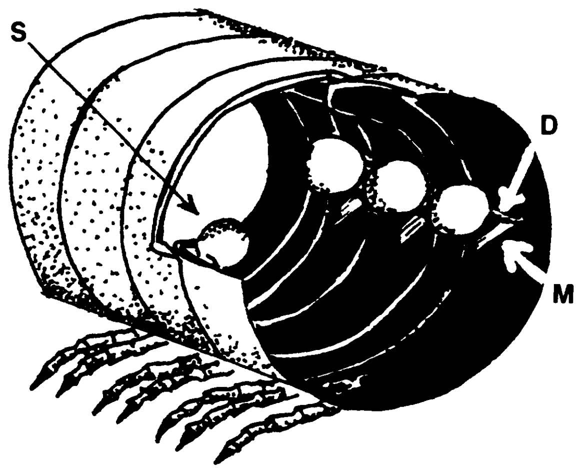
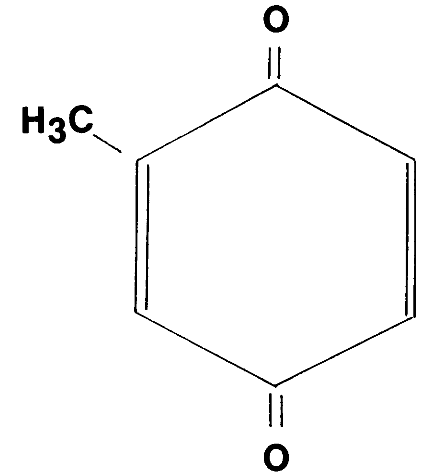
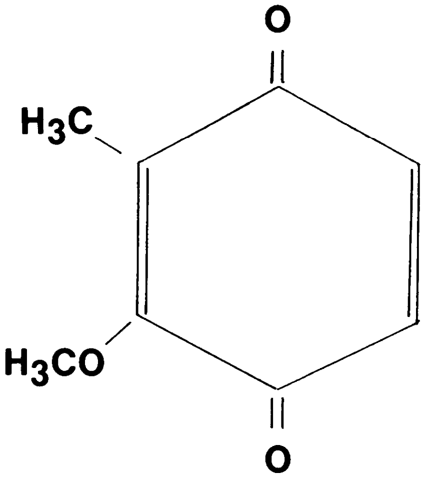


Figure 10. Gland type found in *Narceus gordanus* millipede closely similar to those found in Spirostreptida millipedes (after Eisner, et al., 1978, p. 48). Spherical sac (S) contains defensive liquid. Duct (D) leads to outer orifice. Muscle (M) opens a valve to allow liquid to secrete onto the outer surface of the millipede. Drawing by Randall R. Smith

Another defense tactic employed by the millipede was experienced by one of the authors. When the first myriapod was discovered in Peach Springs Canyon by Williams, his two colleagues were about 100 yards away. Wishing to share his discovery with them, he carefully placed the coiled millipede on a piece of shale and unwisely ran across the desert toward his companions. Losing his balance, he dropped the piece of shale and the animal. Replacing the uninjured, but greatly disturbed millipede, Williams walked to meet his friends. As he showed the coiled specimen to them, the millipede responded to this attention by



a.



b.

Figure 11. Structure of compounds in defensive liquid of *O. ornatus* (after Eisner, et al., 1978, p. 52). Drawing by Randall R. Smith
a. 2-methyl-1,4-benzoquinone
b. 2-methyl-3-methoxy-1,4-benzoquinone

regurgitating an unwholesome-looking black mass to repel his tormentors. The animal was returned to the desert floor.

Defense Systems—Philosophical Concerns

The origin of such defensive chemical systems is an interesting question. Eisner et al. (1978, p. 41) claimed that the defensive liquids secreted by millipedes ". . . have evolved, quite clearly, for protection against predation." Earlier Eisner and Meinwald (1966, p. 1341) in discussing the defense glands in arthropods stated:

> The glands are so variable in number, distribution, and morphological detail that there can be no doubt that they have arisen many times independently in the course of evolution.

Did nature, a chance event or some mystical driving force possessed by these organisms enable them to develop elaborate, well-controlled defense systems often similar in function that can secrete different chemical substances to protect themselves? If such events did occur, chance must be ruled out since something that happens over and over again, (independent evolution of various defense systems) under similar circumstances speaks of design and direction. Can an impersonal, unintelligent entity such as nature, realize that a certain class of animals needs some mode of defense? Can the creature itself will such changes into existence? We believe that such is not possible in a real world. Also increasing the time available to allow the impossible or unlikely to occur, does not solve the problem.

The concept of convergence or parallel evolution to develop similar systems such as defense glands increases the improbability of such occurrences happening time any time again. Such occurrences seem to fit more comfortably into a creationist framework. As an analogy, consider the wing of an airplane. The aircraft obtains lift from this essential structure. Yet in the development of airframes, there have been many types of wings designed and built into aircraft. If you were to allow an "intelligent being from outer space" utterly devoid of the knowledge that wings on airframes had been designed by engineers and ask him to arrange the structures into evolutionary sequences, he undoubtedly would develop many convergence or examples of parallel evolution. We need not resort to chance or natural selection in our modern scientific/engineering era when all of our experiences and observations deny such possibilities. The authors believe that such defense systems in arthropods could have come into existence only by design from an intelligent Creator.

However this view presents the thorny problem that nothing is 100% efficient. Did the Creator then design imperfect defense systems? Of course, the balance of nature (Williams, 1981, pp. 116-17) is involved. However, between the actual creation and our present observation of nature was the Fall of man where the Creator cursed his creation because of man's sin. Inefficiency in nature could have developed at this time (Williams, 1981, pp. 116-17).

If so, what was the purpose of defense glands in arthropods before the Fall if predation did not occur until then? Can major changes in living organisms be postulated as a result of the Fall? Many questions such as these need to be explored by creationists.

Smith (1970, pp. 91-96) discussed population control in animals before and after the Fall. He described

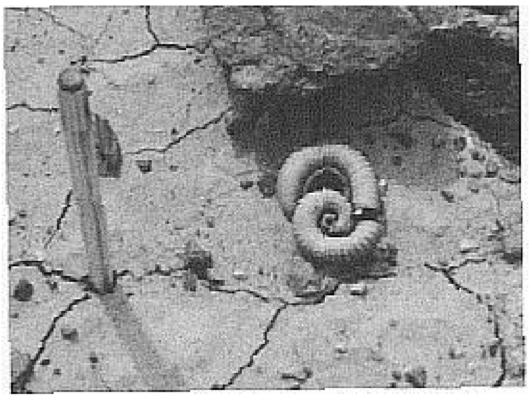


Figure 12. Gray remains (exoskeleton) of a dead millipede in Big Bend National Park—July 1990.

intrinsic population control after the Fall, i.e., cannibalism, fertility, death-age of adults and others. Could reduced fertility or increased age for sexual maturity have been factors in population control without predation before the Fall? Smith (1970, p. 92) realizing the differences in nature today compared to that postulated before the Fall, conjectured that the Fall ". . . brought about modifications to the living world."

Convergence and Parallelisms in Creationist Writings

G. F. Howe has written several papers discussing a creationist view of convergence. Rather than appeal to evolution (divergences followed by convergence), Howe (1965, p. 14) suggested that ". . . resemblances are accordingly attributable to what could be called 'creative interchange of components'." He (p. 14) noted:

> Only one postulate is essential to the creation system—the originating God. He worked by obvious outline (homology) but integrated various patterns in distinct kinds as He chose (analogy).

Parallelisms in bacteria, fungi, algae, vascular plants, guard cells and plant functions were outlined (Howe, 1965, pp. 14-19). In another treatise (1967, pp. 100-105, 115) he detailed parallelisms in algae. Howe (1975, p. 219) in a review noted that the presence of R-bodies in paramecia resembling trichocysts in protozoa and algae are problems for parallelism.

Evan Shute (1969, pp. 135-36) in the section titled "Glands Producing Defensive Secretions," quoted in its entirety below, pointed out weaknesses in assuming convergence.

> Glands of this type are so variable in every way as to demonstrate that they have arisen independently in the course of "evolution." Should we insist that they are vital to phylogeny?
>
> Arthropods of very diverse types may produce similar components in their defensive secretions. Thus the spray trans-2-hexenal occurs in Hemiptera, cockroaches, a myrmecine ant and many plants. Formic acid is secreted by ants, carabid beetles and notodontid caterpillars. The p-benzoquinones are found in beetles, earwigs, millipedes, a cockroach and a phalangid spider.
>
> On the other hand, the defensive glands in the carabid beetles produce compounds as different as m-cresol, p-benzoquinones, salicylaldehyde, formic, tiglic and methacrylic acids. Among millipedes the orders Julida, Spirobolida and Spirostreptida secrete p-benzoquinones; the *Polydesmida*, cyanogenic agents; and a species of *Chordesmida* produces a phenol. The saliva of the reduvid bug *Platymeris radamantus* resembles snake venom, both in number of proteins and in enzyme activity.
>
> What is more surprising is that agents, like 2-hexenal and alpha-pinene found in insects and termites respectively are very widespread in plants. Moreover, in cynanogenic plants, hydrogen cyanide is generated by hydrolysis of cyanohydrin glycosides. How amazing then that the polydesmid millipede, *Apheloria*, also generates hydrogen cyanide by the dissociation of mandelonitrile, the cyanohydrin of benzaldehyde! Citronella was first derived from plants, but now is known to be produced in the glands of an ant, *Acanthomyops*. Surely you are now convinced!

Could we say from the design perspective that the Creator has provided a particular arthropod with the defensive system best suited for its needs or which can be manufactured from its food supply?

Harold Armstrong (1971, p. 232) asked the question "Is convergence credible?" and stated that since vertebrates and invertebrates are much alike, they are often said to have developed by convergence. In quoting creationist A. C. Custance, Armstrong noted that "similar needs and purpose often lead to similar features." Comparing the eyes of an octopus and human eyes, Hamilton (1987, pp. 82-85) said that obviously the former's eyes were designed for a water-dwelling creature. He outlined the similarities and differences between the octopus and human eyes and concluded that they were designed to satisfy the needs of each and convergence is not a necessary explanation.

Using thermoregulation in the sphinx moth as an example, Armstrong (1972, p. 181) attacked the concept of convergence as an explanation for various forms of thermoregulation. In a brief survey of insect flight as a product of convergence, Butt (1980, p. 195) stated:

> Creationists . . . can view the great variety of methods of flight among insects as evidence of the Creator's skill, in giving His creatures equipment to make them fit for the style of life to which He assigned them.

A. J. Jones (1982, pp. 161-62) in a discussion of the concepts of homology and convergence, claimed that they indicated a Designer. The reader is urged to consult the work of Frank L. Marsh (1969, pp. 22-23) for a discussion of the common ancestor concept, resemblances and Genesis kinds as well as homologous structures, convergence and adaptive radiation. Marsh carefully outlines the areas where creationists and evolutionists can agree on resemblances and where disagreement occurs.

Design in Other Quarterly Writings

E. N. Smith (1975, p. 54), writing on body temperature regulation in reptiles, birds and mammals, noted that "God created all animals equally fit to live in their respective niches." Later in discussing how beetles keep warm or cool, he (1976, p. 68) stated ". . . all animals were created equally well adapted to their particular environment."

In discussing termite defensive systems, Ettari (1977, pp. 35-37) believed that evolution was not the answer, only creation could explain their origin. Armstrong (1978, p. 69) commented on an insect defensive countermeasure:

> Certain arctiid moths, which bats evidently hunt with the help of their radar (or, rather sonar) produce sounds, which are believed to confuse the echoes which return to the bats.

In a recent book written for laymen, Duane Gish (1990, pp. 96-101) discussed the amazing, fine-tuned defensive mechanism of the bombardier beetle. He painstakingly explained how such an apparatus could not have evolved but must have been designed fully functioning.

Lammerts (1980, pp. 185-87) stated that Darwin never understood the functions of horns in beetles (thinking they had no usefulness except to attract or impress females). Using several examples, he outlined the purposes of horns of five beetles in the family Scarabaeidae. Lammerts (1985, pp. 196-97) also marveled at the relationship between *Dioclea megacarpa,* a legume and its only predator, a beetle *Caryedes brasiliensi,* an evidence of design. Recently Sanders and Howe (1986, pp. 166-70), while working at the Grand Canyon Experiment Station, discussed many features of insects that indicate creation. Also see Wells (1988, pp. 209-10) and Howe and Sanders (1988, pp. 210-13). Creationists in general conclude that many features in nature could have originated only by intelligent design and preplanning. Chance events offer no help for the complex subject of origins, for it is not a creator of order.

Food

It appears that *O. ornatus* eats mainly ". . . dead organic material (often including bark of desert shrubs), as well as moist soil" (Crawford and Wooten, 1973, p. 1). See Figure 13. Wallwork (1982, p. 42) noted that possibly the millipede may eat algae that often cover the soil in shaded areas of the Chihuahua desert. Smith (1982, p. 27) suggested that since the myriapod ingests soil it ". . . may have an ecological role in conditioning desert soils." Crawford and Wooten (1973, p. 15) believed that the intake of moist soil is necessary for the ". . . ingestion of dry *Ephedra* bark."

The bark and leaves of plants generally eaten (mainly dead material) are as follows: creosote bush, Mormon tea *(Ephedra* spp.), mesquite *(Prosopis* sp.), ocotillo *(Fouqueria splendens),* Russian thistle *(Salsola kali),* tumble weed *(Amaranths graecizans),* cholla *(Opuntia).* Other substances in the millipede diet are any type of dead and living plant tissue including superficial tissues of shrubs, new shoots of annuals and animal feces (Crawford and Wooten, 1973, p. 15). Crawford and Wooten emphasized that the animal has a considerable range of diet. The moisture needed in the millipede diet can be obtained from ". . . succulent leaves, cactus pads, fresh carrion and hygroscopic detritus" (Crawford, et al. 1987, p. 81). Was this organism designed to perform the function of digesting decayed plant matter and releasing the products as waste which can in turn be further digested by other organisms and eventually recycled back into the desert soil to be utilized by the existing flora?

Food and Defense Systems

Since millipedes can release many different noxious and toxic fluids against predators (Eisner et al., 1978, p. 52), it would make an interesting study to determine if diet has any effect on the type or amount of a particular substance emitted. Wolfrom (1990) noted an example where the type of food intake greatly affected a desert organism. Eisner et al. (1978, pp. 55-58) have considered this subject. They surmised ". . . that the animals are not dependent on obtaining preformed alkaloids from their food" (p. 56). However they noted that ". . . it is clear that some millipedes have biosynthetic capabilities which seem closely analogous to those found in plants" (p. 58).

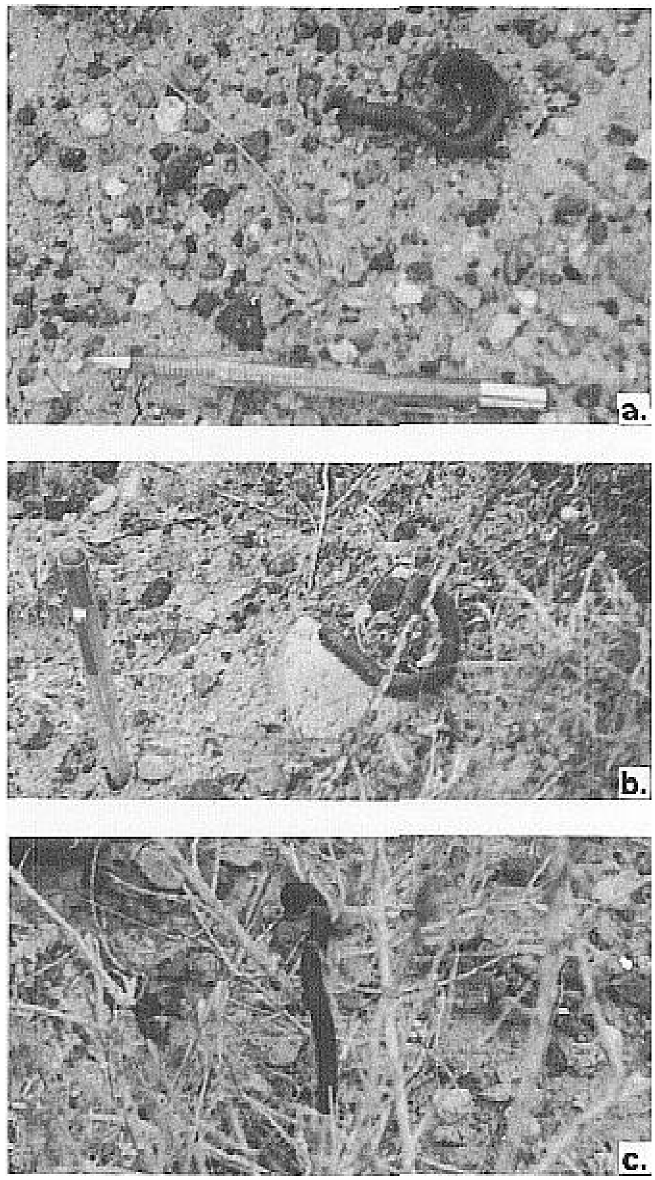


Figure 13. *O. ornatus* specimens foraging in Big Bend National Park—July 1990. a. Millipede eating decayed vegetation on desert floor; b. and c. Millipedes foraging on limbs of desert shrubs.

O. ornatus will feed upon dead and living *Larrea* tissue. It has been suggested that quinones might be one of the possible products formed by *Larrea* phenoloxidase upon the maceration of its leaves (Rhoades, 1977, p. 137). This statement was made within a discussion of the plant's production of secondary chemical substances as defense against herbivores. Can the millipede obtain the defensive fluids needed for its use from the plant matter it ingests or does it possess the necessary enzymes in its defensive system to form the fluids from the plant tissue it eats? Blower (1985, p. 33) stated that:

> Millipedes are not well equipped with specialized enzymes to enable them to digest the leaf

material itself. It is suspected that they rely on the food material elaborated by the microorganisms in their bodies rather than the microbially degraded leaf material.

Some studies have been done on the digestive system of the myriapod. Nunez and Crawford (1976) claimed that digestive enzymes found in *O. ornatus* can hydrolyze *a*- and *b* -glucosides, *a*- and *b* -galactosides, starch cellulose, xylan, pectin, chitin, lipids and amino-tripeptides. Taylor (1982) reported the presence of 76 fungal species in the gut regions of the millipede. Crawford, Minion and Boyers (1983) detected three bacterial morphotypes, fungal mycelia and thelastomatid nematodes in the hindguts they examined.

Do the relative amounts of the two known quinones in the defensive fluids of *O. ornatus* change with diet? Do certain plants and animals both repel predators by emitting or forming quinones when they are "under attack"? Did the Creator use a similar template or logic when He designed the defense systems of desert-dwelling fauna and flora?

Locomotion

Statements can be read to the effect that millipedes are clumsy compared to centipedes (Holland, 1990. p. 129). While eating lunch one day at the picnic tables at Castolon store in Big Bend National Park in July 1990, the authors watched a millipede move across the porch of the store, climb up the vertical exterior wall without any hesitation (Figure 14) until its progress was halted by the gable of the roof. Then it returned vertically down the wall proceeding elsewhere. After this observation, no one will ever convince us that *O. ornatus* is clumsy. The animal never slipped, stumbled or appeared to be in danger of losing its grip. Watching the leg motion pattern is a study in excellently coordinated multi-legged locomotion. Burton and Burton (1989, p. 1613) noted that when millipedes walk ". . . each leg is a little out of step with the one in front so [that] waves appear to sweep back along each side of the body." Alexander (1987, p. 354) stated that Myriapoda move their legs

> . . . with beautiful regularity. Waves of leg movement seem to travel backwards or forwards. The appearance is due to the legs of a segment moving immediately after . . . or immediately before . . . those of a preceding segment.

In the same book, Schone (1987, p. 433) in discussing an animal's ability to orientate without external cues (kinesthetic orientation) noted:

> Another example of such a system is the correcting behaviour shown by a millipede when an obstacle obstructs its course. After a detour, the millipede resumes its previous course obviously using information registered when deviating from the original course to negotiate the obstacle.

Certain millipedes even can hop (Evans and Blower, 1973, pp. 427-28) when disturbed.

If you compare the speed of a millipede to that of a charging bear or a flying bird or insect, you must admit that the millipede is slow however. From the design perspective, was it a mistake to create the millipede locomotion system (Figure 15) in such a manner as to allow only for a slow-moving gait?

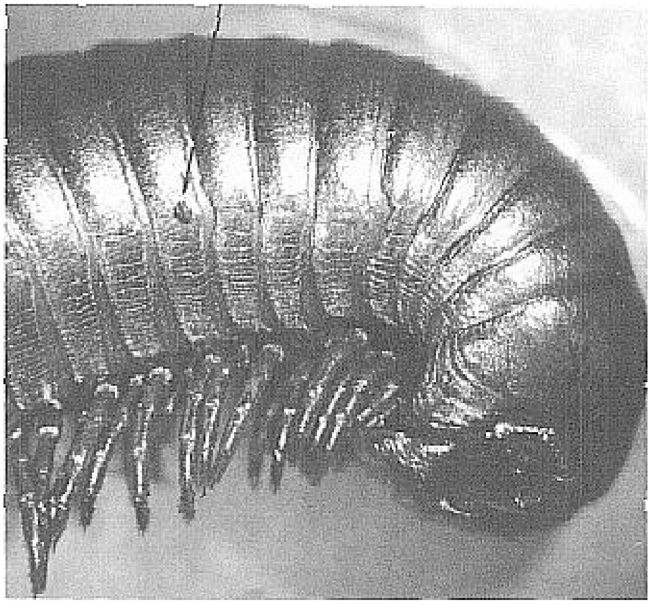


Figure 15. Scanning electron micrograph of gold-coated head and forward trunk portion of an *O. ornatus* exoskeleton showing two pairs of legs per segment in trunk. Exoskeleton found at base of Reed Plateau near Terlingua, TX—July 1990. Arrow indicates a clogged orifice where millipede can release its defensive fluid. Magnification-6.6X. Photomicrograph by R. R. White

The analysis of the locomotion of millipedes as well as other arthropods was accomplished in a series of papers by the late Dr. S. M. Manton of the British Museum of Natural History. A summary of these papers can be found in Manton (1977) and references to the individual papers are on pages 511-12. Manton (1977, p. 32) explained the necessity of slow movement for a millipede:

> A millipede which burrows like a bulldozer by the motive force of its legs . . . can only excel in those pursuits if it is slow-moving, strongly constructed; and possesses many legs so that force can be transmitted to the head end with the body-line curved in any position; it must also possess a host of other structural features. The same animal

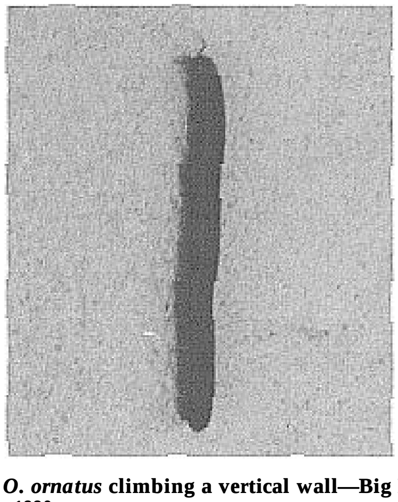


Figure 14. *O. ornatus* climbing a vertical wall—Big Bend National Park—July 1990.

can never run fast and catch flies for a meal as can the highly advanced centipede *Scutigera* . . . with quite different morphology.

Manton developed these characteristics from the evolutionary viewpoint but we prefer the design concept. Consider another analogy. When one wishes to move dirt, a bulldozer would be employed for it has the power from its specialized engine and transmission as well as rugged construction to withstand the digging forces involved, and the track locomotion system to grip and push the equipment forward while under considerable stress. However one would never use a bulldozer in a drag race with a Corvette. Nor would one use the latter to move quantities of dirt. Each has been *designed* for a different task. The Corvette, with an engine and transmission built for fast starts and high speeds, light construction to reduce weight and a locomotion system of tires designed to reduce friction during travel, serves a different purpose than a dozer. Thus the millipede's locomotion system was designed for power, not speed. Can we say that to compensate for its relative slowness when feeding in daylight, the Creator endowed the organism with a defense system to repel some of its potential predators?

The millipede is agile for its function of moving across the desert soil and rocks, foraging up and down the limbs of desert shrubs clinging to them in all manner of positions (upright and upside down). The necessity of burrowing in soil when it must hibernate about three-fourths of the year in the dry and cold seasons in the desert may require the power of "bulldozing." Readers may be interested in consulting a brief creationist review (Lammerts, 1974) of some of Manton's writings on the evolution of Arthropoda.

Exoskeleton

The hard exoskeleton of *O. ornatus* serves the purpose of rugged construction when the need of burrowing arises. Likewise it can offer a possible deterrent to a predator when the millipede is in the defensive coiled position. Being offered nothing but a rigid spherical "shell," a predator may lose interest particularly after the quinones have been released.

The exoskeleton also serves another vital function—the resistance to water loss as the animal feeds in the hot desert. Crawford et al. (1987, p. 81) consider that *O. ornatus* has a relatively waterproof cuticle (Figure 16) which enables it to survive without rapid dessication (along with the animal's ability to take in water readily). An energy dispersive analysis (EDX) was conducted on the exoskeleton found at the base of the Reed Plateau. The remains were still brown in color indicating a fairly recent death. Calcium and phosphorus were the major constituents indicating the presence of calcium phosphate (oxygen is not detected with this EDX equipment). Traces of magnesium and sulfur were also found. See Figure 17. Both the legs and segments showed essentially the same composition.

Summary

Although Hadley (1973, p. 347) claimed that the processes of natural selection, diversification and specialization along with adaptation have allowed desert flora and fauna to survive the extreme conditions present there, we prefer the interpretation that *O. ornatus* was designed for this purpose.

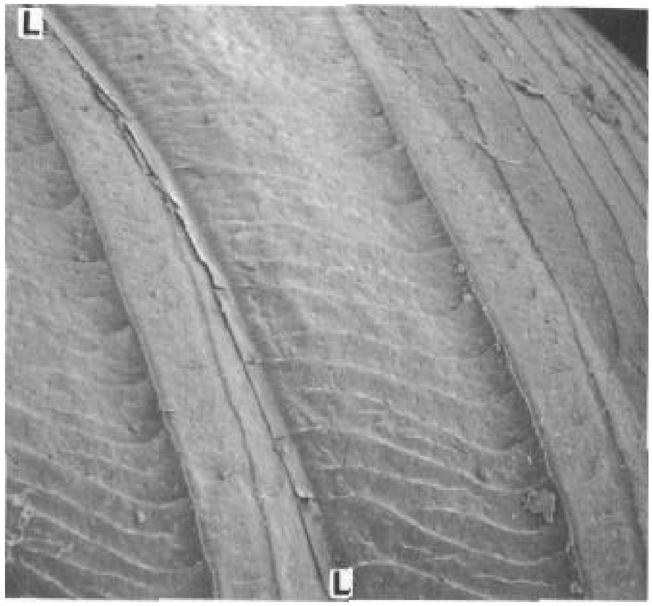


Figure 16. Scanning electron micrograph of gold-coated segments of *O. ornatus* exoskeleton. Note close fit where one segment overlaps another one (L). Magnification 36X. Photomicrograph by R. R. White

When several types of different organisms have the same pattern of adaptation, the explanation offered often is convergence (parallel evolution). We believe that the Creator could have used the same template, blueprint strategy or plan of design for different organisms to cope with a similar environment. A suitable solution to a foreseen survival problem is an indication to us of intelligence rather than the work of brute, undirected natural processes.

If *O. ornatus* was designed to be a "recycler" of dead plant matter in a desert environment, it appears that its structure, function and behavior patterns discussed in this paper can be explained within this design criterion. See Howe and Williams (1990) for a discussion of a desert plant survival potential within a design framework. If a reader is interested in other field studies done on *O. ornatus*, it is suggested that he consult the papers of C. S. Crawford. The fascinating study of defensive secretions emitted by arthro-

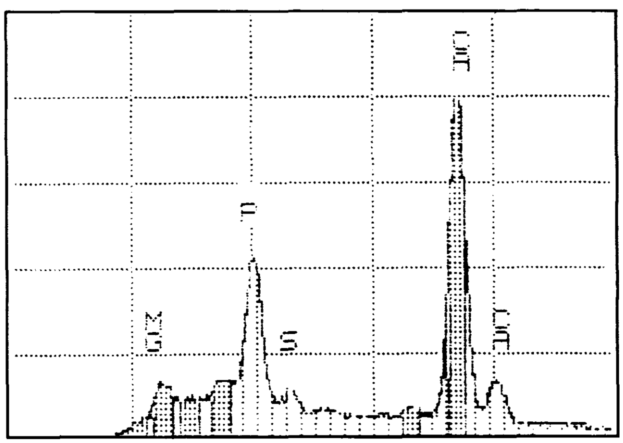


Figure 17. EDX analysis of *O. ornatus* segment and leg. Mg — magnesium, P — phosphorus, S — sulfur, Ca — calcium.

pods can be followed by consulting the articles of Thomas Eisner.

Acknowledgments

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QUOTE

The first polarity is between absolutism and teleology. Despite the philosophical objections which can and have been raised against grounding ethics in divinity, there can be no doubt that in the Old and New Testaments the reason certain acts, attitudes, and desires are considered wrong is because they are contrary to God's nature and consequent will for His creation.

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