at −80°C. In use, extruded gels containing A components were immersed in the solution of P at 4°C for a period of 3 to 5 hours. Gels were then washed twice with buffer and incubated further with 3,4-dihydroxyphenylalanine or tyrosine (0.4 mg/ml in phosphate buffer) to show the locations of the phenol oxidases produced. The gels were incubated (Fig. 1) for about 20 hours at 4°C before the photographs were made, but the bands could be detected in less than 1 hour; they appeared initially as red rings and turned black in a short time.

Obviously from the results (Fig. 1) the components A_1 and A_2 differ both in electrophoretic behavior and in specificity with respect to oxidase activity. A_1, which is present in the 47- and 56-percent ammonium sulfate fractions, yields primarily a tyrosinase, whereas A_2 which appears also in the 43-percent fraction yields primarily a 3,4-dihydroxyphenylalanine oxidase. The latter oxidase gives a weak reaction with tyrosine after several days, but this may be due to oxidation in air of tyrosine to dihydroxyphenylalanine. In any case there is an extreme difference in reaction rates. On electrophoresis the component A_3 in the 41-percent fraction moves only slightly differently from A_2, but it is very nearly completely separated by the salt fractionation. As shown, A_3 also yields primarily a diphenol oxidase.

As to the activation processes which yield the phenol oxidases, it may be noted that if activation is permitted prior to electrophoresis then A_1, A_2, and A_3 do not appear on the gels, and oxidase function is found at or near the starting gel interface. After activation, furthermore, oxidase function is easily sedimented in the centrifuge just as observed (*1*) for the crude extracts of adult flies. For these reasons activation may be represented as a process of assembling the enzyme from the subunits represented as A_1, A_2, or A_3 plus a component of the P fraction. Our data do not rule out a participation of proteolytic action in activation, as indicated for diphenol oxidase in *Calliphora* (*6*); in fact the P fraction does contain two components of which one functions catalytically in the activation process.

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Annelid Ciliary Photoreceptors

Abstract. *The photoreceptor cells of the tube-dwelling polychaete* Branchiomma vesiculosum *contain stacked disc-shaped membranous sacs which are the expanded and flattened outer membranes of cilia.*

The light-sensitive organelle of vertebrate photoreceptors is a stack of membrane-covered discs originating from a cilium-like outgrowth of rod or cone cell (*1*). The photosensitive organelle of the arthropod retinula cell is a field of microvilli apparently unassociated with ciliary apparatus at any stage of development (*2*). Having surveyed the evidence on the fine structure of presumed light-sensitive organelles in several phyla, Eakin (*3*) suggests with some reservation that photoreceptors of ciliary origin may be restricted to echinoderm-vertebrate stock, while those of nonciliary (rhabdomeric) organization may be the rule for the annelid-arthropod line.

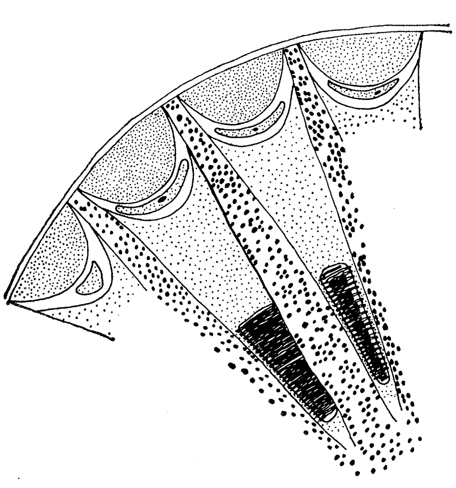

Fig. 1. A schematic drawing of part of a radial section through an eye of *B. vesiculosum* to illustrate its gross organization. Nuclei of lens cells are shown as crescent-shaped structures; those of the receptor cells are off the plane of section. The two completely drawn units are depicted as though cut at right angles to each other and they correspond to the left and right units, respectively, of Hesse (*5*, Fig. 64).

We wish to draw attention to an annelid photoreceptor whose presumed photosensitive structures are of distinct ciliary origin. The tip of each branchial filament of the tube-dwelling polychaete *Branchiomma vesiculosum* possesses a dark, spherically shaped eye which is an aggregate of some 40 to 80 cone-shaped receptive elements separated from one another by dense pigmentation (Fig. 1). Each conical element is composed of a lens cell sitting atop a receptor cell. According to Brunotte (*4*) the apical (deep) half of each receptor cell is filled by a body of lamellar appearance. Hesse (*5*) de-

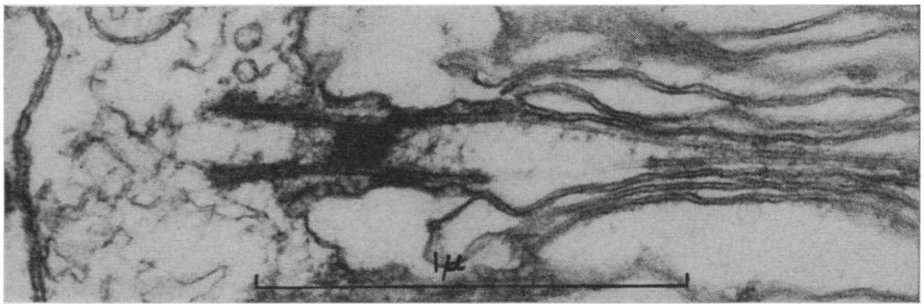

Fig. 2. Electron micrograph of a cilium emerging from the cytoplasmic wall (left) of the apical cavity and projecting into it (toward the right). The plane of section corresponds to that of Fig. 1. The outer membrane of the cilium and two of its axial filaments can be followed into the "lamellar" region, whose edge is shown at the right of the micrograph. Above and below this "cilium" are the edges of discs arising from other basal bodies.

scribes the same region as having a central core (of fine structure which we cannot readily relate to our observations) joined by radially directed fibrils to dense little rods distributed around part of the periphery of the cell. Viewed through the electron microscope, Brunotte's lamellar body is seen to be a cavity in the cell cytoplasm filled by a stack of about 400 disc-shaped, membranous sacs with their somewhat undulating faces perpendicular to the optical axis of the cell. The cytoplasmic wall of the cavity is invested at one side with about 400 centripetally pointing ciliary basal bodies; each sac of the cavity is the expanded and flattened outer membrane of one of these cilia (Fig. 2).

Inside the cytoplasm the basal bodies, which seem to lack striated rootlets, have nine triplets of fibrils in a cartwheel arrangement; one filament of each triplet is lost as the cilium emerges into the cavity. There are no central filaments.

The discs are closely stacked so that their membranes (about 60 to 70 Å thick) are separated by a constant (about 20 to 30 Å) distance. Their internal space, which is continuous with that of the cilium, is of more variable dimension (12 to 1000 Å) and includes the extensions of the axial filaments of the cilia. These become progressively disorganized and terminate one by one, having penetrated a third of the disc diameter.

A detailed report on these photoreceptors is in preparation.

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Defensive Spray of a Phasmid Insect

Abstract. *The walkingstick,* Anisomorpha bupresteoides, *has two defensive glands in its thorax from which it ejects an aimed spray when disturbed. Contact stimulation is the usual trigger for the discharge, but birds may elicit the spray by merely approaching the insect. The secretion proved effectively deterrent to ants, predaceous beetles, mice, and blue jays, but not to an opossum.*

The large Southern walkingstick, *Anisomorpha buprestoides*, is known to eject a defensive spray when disturbed (*1*). The secretion is lachrymogenous, and its vapors are painfully irritating when inhaled. The active principle, anisomorphal, is a terpene dialdehyde (*2*), chemically allied to nepetalactone (catnip) and certain other cyclopentanoid monoterpenes produced by insects and plants (*3*). This report deals with the remarkable adaptive refinements of this chemical defense mechanism.

The secretion is produced and stored in two elongate, sac-like glands situated in the thorax and opening just behind the head (Fig. 1*B*). Discharge is effected by appropriate compressor muscles that surround the glands (Fig. 1*C*). All instars of both sexes possess functional glands.

Anisomorpha discharges instantly in response to mild traumatic stimulation as, for example, when individual legs are pinched with forceps, or when the body is tapped or persistently prodded. Against a dark background, the spray is clearly visible. Ejection is from one gland or from both, depending on whether the stimulus is applied unilaterally or bilaterally (Fig. 2). Marksmanship is precise: the spray invariably drenches the particular instrument used for stimulation.

As many as five consecutive bilateral discharges may be elicited from an adult female before the glands are depleted. Within 7 to 15 days, her secretory supply is restored. The male is considerably smaller, and usually sprays only once or twice. Interestingly, the male is nearly always found astride the female (Fig. 1*A*), even while not mating; the sexes are often found already associated in this fashion while still in their immature nymphal stages. Whether the "pooling" of defensive resources is an important adaptive justification of the partnership remains to be seen.

To determine the defensive effectiveness of the spray, individual adult females of *Anisomorpha* were offered to a variety of caged predators, including ants (*Formica exsectoides*, *Pogonomyrmex badius*), carabid beetles (*Calosoma prominens*), mice (*Peromyscus leucopus*), a mouse-opossum (*Marmosa demararae*), and blue jays (*Cyanocitta cristata*) (*4*).

The ants and beetles were instantly repelled by the aimed discharges induced by them whenever they bit one of the walkingstick's appendages. The mice approached the walkingsticks and sniffed them on contact but were promptly sprayed, and they fled before inflicting injury. The spray caused pronounced cleansing activities in these three types of predators (*5*), but no detectable permanent ill-effects. Individuals of *Anisomorpha* with depleted glands were overcome and eaten.

The opossum proved to be an unusually persistent predator. It initiated its attack by grasping the walkingstick in its jaws, and in return was invariably sprayed on the head (Fig. 1*E*). It then scurried about in obvious discomfort, attempting to cleanse itself of secretion by rubbing its muzzle in the litter on the floor of the cage, but, instead of abandoning the insect, it held it tenaciously with a front paw (Fig. 1*F*). Squeezed in this fashion, the walkingstick continued spraying, but its discharges were now aimed at the relatively insensitive paw of the opossum and appeared to miss the sensitive eyes and snout. Eventually, after its secretion was ineffectually expended in this fashion, the walkingstick was eaten (Fig. 1*G*). Additional walkingsticks were offered daily over a period of a week, but the results remained essentially identical; the opossum became no less aggressive with time.

The results with the jays were especially dramatic because the birds often (15 of 21 instances) received the full impact of an aimed discharge before they actually contacted the walkingsticks. Sometimes the birds