References and Notes

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Vision in Cubomedusan Jellyfishes

The report by Wald and Rayport (*1*) on visual physiology in alciopids complements the recent ultrastructural study (*2*) of the remarkable eyes of these worms. However, adding annelids to molluscs, arthropods, and vertebrates does not complete the list of animals with elaborate eyes (*3*). One outstanding example is found in the cubomedusan jellyfishes (*4*) of tropical marine waters, the eyes of which were described by the end of the last century (*5, 6*).

Cubomedusans have as many as 24 eyes located near the bell margin, and the most complex of these eyes have an epidermal cornea, spheroidal cellular lens, and upright retina (Fig. 1). The retina is composed of layers, corresponding to those of alciopids: a presumably sensory layer, a pigmented layer, a nuclear layer, and a region of nerve fibers. The cells described by Berger (*6*) as sensory contain a zone of pigment granules at the level of the pigmented layer and, in the sensory layer, long "axial fibers" which he tentatively identified as cilia and clearly illustrated with basal bodies. There are roughly 11,000 sensory cells in the eye (*7*), a number comparable to that estimated for alciopids (*1*). Elongate pigment-filled cells (supportive cells?) extend between the sensory cells in sections from animals fixed in the light, and are partially withdrawn in sections from animals fixed in the dark; Berger interpreted these observations as evidence for a kind of adaptation to light and dark, similar to that in arthropodan and other complex eyes. Between the lens and the retina is a "capsule" through which narrow processes extend from the tips of the long pigment cells to the cells of the lens, features which Berger (*6*) speculated might be involved in accommodation for near and far vision.

Like alciopids, cubomedusans have been studied little (*8, 9*). They are agile and rapid swimmers; specimens only about 3 cm high have been clocked at up to 6 m per minute (*10*). They are active both by day and by night, and in the dark exhibit strong positive phototaxis (*9, 10*); they will orient accurately to the light of a match as much as 1.5 m away even if the match is extinguished before orientation is completed (*9*). Their combination of speed and fine directional sensitivity to light might enable them to orient to luminescent prey at night. Larson (*10*) observed that cubomedusans attracted to a night-light "neither swam toward prey nor avoided obstacles," but the interesting possibility of image-forming vision under more normal conditions remains. Cubomedusans are unique among cnidarians in engaging in copulation (*11*); might the eyes be somehow involved in this behavior?

Cubomedusan eyes are so similar to the camera eyes of vertebrates and cephalopods that it would be surprising if studies of them, on the level now begun for alciopids (*1, 2*), did not yield valuable perspective and reveal some more elaborate functions than ordinary directional sensitivity.

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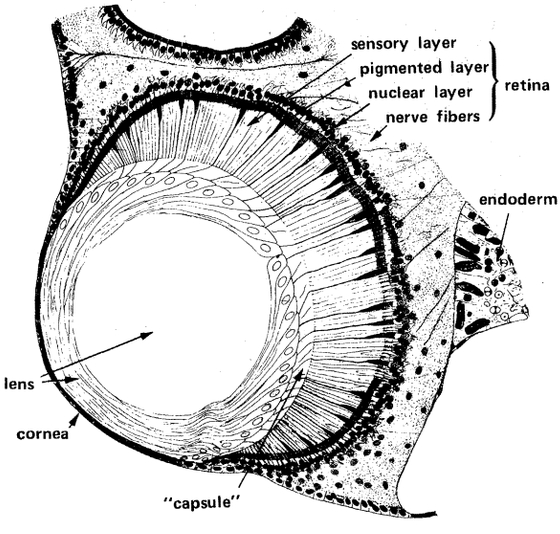

Fig. 1. Section of cubomedusan eye, from Berger (*6*, figure 7); relabeled. Part of the pigmented zone is drawn without pigment to reveal the basal bodies of the "axial fibers" that extend distally through the sensory layer. Berger states that in small specimens, the lens is cellular throughout; in larger adults, the central region often shows less distinct cellular features or even appears homogeneous, as drawn here.

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1. G. Wald and S. Rayport, *Science* **196**, 1434 (1977).
2. C. O. Hermans and R. M. Eakin, *Z. Morphol. Tiere* **79**, 245 (1974).
3. Elaborate lensed eyes, organized on the scale of organelles, are found even among dinoflagellates (protistans); see C. Greuet, *Protistologica* **4**, 209 (1968). See also review by R. M. Eakin, in *Handbook of Sensory Physiology*, H. J. A. Dartnall, Ed. (Springer, Berlin, 1972), vol. 7, No. 1, pp. 625–684.
4. Cubomedusans are usually placed in the class Scyphozoa, phylum Cnidaria. It has been argued that they constitute a separate cnidarian class, the Cubozoa; see B. Werner, *Helgol. Wiss. Meeresunters.* **27**, 461 (1975).
5. C. Claus, *Arb. Zool. Inst. Wien* **2**, 221 (1878); W. Schewiakoff, *Morphol. Jahrb.* **15** (No. 1), 21 (1889); F. S. Conant, *Mem. Biol. Lab. Johns Hopkins Univ.* **4** (No. 1), 1 (1898); see also L. H. Hyman, *The Invertebrates* (McGraw-Hill, New York, 1940), vol. 1, pp. 511–515.
6. E. W. Berger, *Mem. Biol. Lab. Johns Hopkins Univ.* **4** (No. 4), 1 (1900).
7. We arrived at this estimate by counting the sensory cells in figure 1 (cross section) of Berger (*6*); we then calculated the average density (3.3×10^5 cell/mm^2) and estimated the retinal area, assuming that the retina occupies half of a spherical eye 145 μm in diameter (measured inside pigment layer on figure 7 of Berger; see our Fig. 1).
8. Cubomedusans are notorious, however, for their painful, somtimes deadly sting, and they are commonly known as "sea wasps"; studies have centered on their effects on bathers [for example, see Barnes (*9*)].
9. J. H. Barnes, in *The Cnidaria and their Evolution*, W. J. Rees, Ed. (Academic Press, New York, 1966), p. 307.
10. R. J. Larson, in *Coelenterate Ecology and Behavior*, G. O. Mackie, Ed. (Plenum, New York, 1976), p. 237.
11. B. Werner, *Mar. Biol.* **18**, 212 (1973).

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