In their book on ‘The biology of millipedes’ Hopkin & Read (1992) stated that “despite being one of the better-studied areas of millipede biology, we have still some way to go until structure and function of the sensory receptors and organs are as well-understood as those of insects” (p. 86).

As a matter of fact, this statement still holds true, as only very few works on either fields of sensory morphology, physiology, or behavior of diplopods have been published since then. So, we are perfectly aware of not coming beyond scratching on the surface of a review on the sensory biology of these animals but in this chapter we rather intend to provide a fresh look on what is currently known morphologically of diplopod sense organs from the perspective of evolutionary morphology. In particular, we evaluate here to which extent present knowledge of diplopod sense organs helps resolving arthropod interrelationships.

Prior to the summary of Hopkin & Read (1992), few reviews of sensory biology of diplopods were released focusing either on external morphology (Eisenbeis & Wichard, 1985), fine structural anatomy (Haupt, 1979) or behavioral implications of their sense organs (Cloudsley-Thompson, 1951a; Barnwell, 1965). Haupt (1979) categorized millipede sense organs as simple or complex. Simple organs are cuticular sensilla, whereas complex organs are eyes, Tömösváry organs, and trichobothria. The diversity of sense organs covered by the current body of literature is pretty much restricted to the millipede’s head. Those sense organs undoubtedly occurring on the trunk (sternites, tergites, rings, etc.), walking legs and gonopods are exceedingly understudied.

EYES

History of research

Like eye-bearing Chilopoda (see Müller et al., 2011 for review), all Diplopoda lack median eyes (e.g. Spies, 1981; Sierwald & Bond, 2007). If eyes are present, they always belong to the class of lateral eyes termed ommatidia according to Richter et al. (2010). Small, spherical photoreceptor organs, called accessory lateral eyes, may also be found deeply sunken into fronto-lateral, perioptical compartments of the protocerebrum in some Julidae (Heithier & Melzer, 2005). Single or several up to almost a hundred (e.g., 90 in Spirostreptus macracanthus) camera-type, corneal lens eyes are found at either side of the head. Fossil representatives of Diplopoda (e.g. Glomeropsis; see also Chapter 16) have been found in Lagerstätten of the Upper Carboniferous bearing more than 1000 closely aggregated ommatidia at either side of the head (Kraus, 1974).
First descriptions of diplopod eyes date back to the 1820s when Müller (1829) provided basic anatomical insights from the eyes of “Iulus sp.”. Further contributions to millipedes’ gross eye anatomy were given by Leydig (1864) and Schultz (1868) and again, more comprehensively, at the end of the 19th century by Grenacher (1879, 1880), Gruber (1880), Willem (1892), and Hesse (1901). These works are however limited to representatives of Penicillata (Polyxenus sp.), Glomeridae (Glomeris spp., Fig. 9.1A), and Julidae (“Iulus sp.”, Fig. 9.1E, F; Ommatoiulus sabulosus). This set of investigated species represents only a fraction of millipedes possessing eyes. The focus on penicillate, glomerid, and julid eyes continues to date. The few transmission electron microscopic (TEM) studies available so far revealed valuable information on the ultrastructural organization of the eyes (Bedini, 1970, Fig. 9.1B, C; Spies, 1981, Fig. 9.1D, G, H; Paulus, 2000; Müller et al., 2007, Fig. 9.7G (colour version, see Plate X; this chapter)), but only Spies (1981) included data on polyzoniid Colobognatha (Polyzonium germanicum, Fig. 9.1D) and chordeumatid Nematophora (Craspedosoma simile, Fig. 9.1H). Among Penicillata, Müller et al. (2007) contributed new ultrastructural data on the ommatidia including the subtaxon Synxenidae. The anatomy of adult eyes of many recent Chilognatha, such as Sphaerotheriida, Siphonocryptida, Stemmiulida, Callipodida, Spirobolida, and Spirostreptida still remains unknown (e.g. Enghoff et al., 1993; see character matrix of Blanke & Wesener, 2014).

**External morphology and occurrence of eyes**

Blind taxa are found frequently in Chilognatha, such as in Pentazonia (Glomeridesmida), Colobognatha (Platydesmida, Siphonophorida), some Juliformia (e.g. Typhloiulus spp.) as well as all Polydesmida (Attems, 1926; Spies, 1981; Enghoff, 1984; Blanke &