External morphology of eggs of *Macronemurus bilineatus* and *Megistopus flavicornis* (Neuroptera, Myrmeleontidae): a scanning electron microscopy study

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Abstract: The eggs of *Megistopus flavicornis* (Rossi, 1790) and *Macronemurus bilineatus* Brauer, 1868 were studied by light and scanning electron microscope and are described in detail in this paper. Both species have roughly elongate and cylindrical eggs with rounded ends and have 2 flattened disc-like micropylar processes at the opposite poles. The chorionic surface is tuberculated and differs between the 2 species. The eggs of *M. flavicornis* additionally have some rows containing polygonal pattern of exochorion near the micropyles. Moreover, a number of morphological differences between the 2 species are noted.

Key words: Scanning electron microscope, chorion, eggshell, micropyle

Introduction

The surface structure of insect eggshells with various chorionic modifications has morphological, physiological, and taxonomic significance (Salkeld, 1983, 1984; Downey and Allyn, 1984; Gaino et al., 1987; Sahlén, 1996; Suludere et al., 1999; Wolf and Reid, 2004). Scanning electron microscopy is an ideal tool for detailed description of surface morphology and ultrastructure of the eggs (Hinton, 1981; Margaritis, 1985; Suludere et al., 2000a, 2000b;
Candan and Suludere, 2006). Several authors have illustrated morphological details of eggs of Neuropterid species. However, accurate knowledge of the egg ultrastructure is still lacking for many taxa (Mazzini, 1976; Hinton, 1981; Monserrat, 1985, 1996; Gepp, 1990; Cutler, 1993; Monserrat and Martinez, 1995; Shields and Pupedis, 1997; Popov, 2002; Candan et al., 2005; Satar et al., 2006, 2007). Suludere et al. (2006) studied the egg of another Neuropterid, Dielocroce baudii (Griffini), using scanning electron microscopy (SEM). Recently, Kubrakiewicz et al. (2005) examined and compared the eggs of 5 Neuropterid species, including 1 of the Myrmeleontidae species Euroleon nostras (Fourcroy).

In the present study the eggs of 2 more Myrmeleontid species, Megistopus flavicornis (Rossi, 1790) and Macronemurus bilineatus Brauer, 1868, were examined using SEM for the first time. The chorionic structures are described below.

Materials and methods

Females of both species were collected in Turkey, Macronemurus bilineatus from Bolu (Kibriscik, Karaköy), (40°26′25″N/31°50′13″E, 1234 m, on 25.07.2006) and Megistopus flavicornis from Karabük (Bolkuş village), (41°09′35″N/32°33′29″E, 237 m, on 23.06.2006). Gravid females were individually separated and placed separately into plastic jars in order to obtain fresh eggs under laboratory conditions. Initial observations and examinations of the eggs were made with an Olympus SZX7 stereomicroscope and photographed with the Olympus digital camera (5.1 MP) mounted on it. The eggs were immersed in 70% ethanol for subsequent SEM. Brush cleaned and air dried eggs were mounted with double sided tape on SEM stubs and coated with gold in a Polaron SC502 Sputter Coater. Several eggs were examined and 10 of them were measured with a JEOL JSM 6060 scanning electron microscope at 10 kV in Gazi University (Faculty of Arts and Science, Electron Microscopy Unit, Turkey).

Results

The egg shape and chorionic structures of Macronemurus bilineatus and Megistopus flavicornis are presented in Figure 1 and Figure 2. The eggs of both species are roughly elongate and cylindrical with rounded ends (Figures 1A, 2A); an average of 1.11 × 0.75 ± 0.1 mm and 1.21 × 0.75 mm, respectively.

The eggs of both species have 2 flattened disc-like micropylar apparatus per pole (Figures 1A-D, 2A-D). In M. bilineatus, the micropylar apparatus in the anterior and posterior pole are morphologically similar and measure on average 58-85 μm in diameter. M. flavicornis also has similar micropyles and their diameters range from 56 to 79 μm. The basal periphery of the micropylar knob is divided into 10-12 lobes in M. bilineatus and 11-12 lobes in M. flavicornis, distributed around the margin of the micropylar process with roughly circular orifices of various diameters, in the center of each lobe (Figures 1C-D, 2C-D).

With both light microscopy and SEM at low magnifications, the egg surface of both examined species appears smooth (Figures 1A, 2A), except for the micropylar regions. However, at high magnifications, the SEM revealed that the entire surfaces of both species are covered with raised, irregular small tubercles (Figures 1E-F, 2E-F). In M. bilineatus, most of the tubercles are distributed singly; the diameters of these projections range from 1.1 to 1.9 μm (Figure 1F). On M. flavicornis eggs, the chorionic surface contains various shaped tubercles, some of which are connected to each other (Figure 2F). The diameters of these projections range from 0.8-9.1 μm to 0.8-1.0 μm. The eggs of M. flavicornis have some rows containing polygonal shapes only near the micropylar area at each pole. The borders of the polygons lack tubercles (Figures 2E-F). The interior of the polygons is similar to that of the remaining parts of the egg. In both species, the inter-tubercle area is irregular (Figures 1F, 2F).

Discussion and conclusion

The eggs of species of Neuroptera vary in shape, i.e. ovoid, elongate, cylindrical etc., and size. For instance, eggs can vary from almost spherical to ovoid (Ascalaphidae, Nemopteridae, Myrmeleontidae, Psychopsidae) as well as being elongated (Coniopterygidae, Dilaridae, Osmyliidae, and sometimes in Myrmeleontidae) or cylindrical (Berothidae, Chrysopidae, and Mantispidae).
Figure 1. The eggs of *Macronemurus bilineatus*, SEM micrographs. A. General view of egg with 2 micropyles (arrows), B. Micropyle at 1 pole, C. Top view of micropyle in detail, D. Side view of micropyle and micropylar orifices in detail, E. Chorionic surface, F. Tubercles and chorionic surface in detail.
Figure 2. The eggs of *Megistopus flavicornis*, light and SEM micrographs. A. General view of egg with 2 micropyles (arrows) (LM), B. Polygonal pattern (▲) of chorionic surface and micropyle at 1 pole (SEM), C. Top view of micropyle in detail, D. Side view of micropyle and micropylar orifices in detail, E. Polygonal pattern of chorionic surface near micropylar area, F. Tubercles and chorionic surface in detail.
The eggs in some families, such as Berothidae, Chrysopidae, Mantispidae, and Nymphidae, are deposited on stalks (Mazzini, 1976; Gepp, 1990; Minter, 1990; Růžička, 1997). The eggs of *M. bilineatus* and *M. flavicornis* are roughly elongate and cylindrical with rounded ends similar to those of other Myrmeleontidae.

In neuropterans, the number, shape, and size of the micropylar apparatus differ depending on the species. In some families of Neuroptera, such as Mantispidae, Chrysopidae, and some Berothidae, eggs have a micropylar process at one end and a short, thin, flexible stalk at the other, which fastens the eggs to the substrate (Mazzini, 1976; Gepp, 1990). In addition, in some families of Neuroptera, such as Nemopteridae, Psychopidae, Dilaridae, and Coniopterygidae, only one micropyle exists and there is no egg stalk (Gepp, 1990; Minter, 1990; Michel, 2001; Kubrakiewicz et al., 2005). In *M. bilineatus* and *M. flavicornis*, the micropyles resemble a flattened disc in which the basal periphery of the micropylar knob is divided into lobes with a micropylar orifice. The numbers of lobes or indentations vary within the Neuroptera; some species have 8-10 lobes as in *Mantispa sayi*, 30 as in *Chrysopeola carnea*, or 6-8 as in *D. baudii* (Mazzini, 1976; Shields and Pupedis, 1997; Suludere et al., 2006). The eggs of *M. bilineatus* and *M. flavicornis* have 10-12 and 11-12 lobes, respectively.

The egg surface of Neuroptera shows very different sculpturing, such as smooth surface in *Croce schmidti* (Satar et al., 2007), with chorionic reticulation in *Mantispa sayi* (Shields and Pupedis, 1997), with sponge-like elevations in *Hemeroobia marginata* (Gepp, 1990), with granular structures in *Pterocroce capillaris* (Monserrat, 1985), with tubercles or papilla-like projections connected by narrow bridges in some Chrysopidae species (Mazzini, 1976; Gepp, 1990), and with polygonal patterns in *Coniopteryx* (C.) *tineiformis* and *Conwentzia psociformis* (Gepp, 1990), *Euroleon nastras* (Kubrakiewicz et al., 2005), and *Nemoptera sinuata* (Candan et al., 2005). In *Dielocroce baudii*, the egg surface has 2 types of small raised projections, which lack connections between them (Suludere et al., 2006). The chorionic surface of *M. bilineatus* and *M. flavicornis* is covered with small, raised, irregular tubercles. The structure and distributions of projections or tubercles differ between these species. *M. flavicornis* has some rows containing polygonal shapes near the micropylar area at both poles as opposed to that of some species previously mentioned above in which the entire egg has a polygonal chorionic pattern.

General classifications of Neuroptera are mainly based on adult characters (Monserrat, 1996) and egg stage is often overlooked as a taxonomic tool. However, chorionic sculpturing can provide distinctive characters as noted above. Consequently, it will be necessary to investigate the surface designs of additional species of Neuroptera utilizing the SEM to fully explore their use as taxonomic markers.

References


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