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Short Communication

Bicephality in *Eratigena atrica* Larva

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ABSTRACT

The study contains a detailed description of a larva of the *Eratigena atrica* spider, which had a well-developed prosoma and an additional, partly developed head with two segmented pedipalps and one chelicera with two fangs. The larva was obtained as a result of a teratological experiment based on the application of temperatures of 14 and 32°C changed every 12 h for the first ten days of spider embryogenesis.

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Authors' Contributions
TN conceived and designed the study and wrote the article. JT collected spiders, performed experimental work and took photographs.

Key words
Spider, Teratology, Temperature fluctuations, Bicephaly.

Bicephaly is one of the most complicated and rare anomalies in arthropods, and particularly in arachnids. Matthiesen (1979) identified this deformity in the scorpion *Tityus cambridgei* (Pocock): the affected individual had a double prosoma, two sets of eyes and four pedipalps. Rempel (1954) described the deformity in two *Latrodectus mactans* (Fabr.) spider embryos but he failed to specify the cause. As has been confirmed in laboratory experiments, in the natural environment there are many factors, including temperature, which can disturb animal embryogenesis (Itow and Sekiguchi, 1979, 1980; Itow, 1980, 1982; Buczek, 2000). Embryo incubation at temperatures significantly different from the species optimum can be a powerful teratogenic factor leading to a number of developmental deformities (Juberthie, 1962, 1963a, b; Jacuński, 2002a, b, Jacuński *et al*., 2004; Napiórkowska and Templin, 2013). *Tegenaria atrica* C.L. Koch spiders with two heads were obtained by Mikulska and Jacuński (1970) and (1971) under laboratory conditions, after raising the temperature of embryo incubation. A similar effect was achieved by the application of temperatures higher and lower than the optimum during the first days of spider embryonic development (Jacuński and Templin, 2003; Templin *et al*., 2009). In the affected spiders bicephaly was accompanied by additional changes, which significantly disturbed the morphology of the anterior body part. Histological analysis of two-headed *Tegenaria atrica* spiders confirmed that they had two brains (Jacuński and Templin, 1992). The results obtained by Napiórkowska *et al*. (2016) indicated a close relationship between the morphological deformity and the structure of the brain/brains: fusion of pedipalps and chelicerae were accompanied by the fusion of corresponding ganglia. The absence of pedipalps was accompanied by the absence of corresponding ganglia.

The aim of this study was to show the relationship between temperature as a factor which disturbs morphogenesis and anomalies in the front of the prosoma.

Materials and methods

Teratological studies were conducted on embryos of *Eratigena atrica* (Agelenidae), obtained from females caught in the summer months 2015 near the towns of Toruń and Chełmża (Poland). Each batch of laid and fertilized eggs was divided into two parts, one of with was the control maintained in conditions optimal for the embryonic development of this spider species, *i.e.* the temperature of 21-23°C and relative humidity of 70% and the other was subjected to alternating temperatures of 14 and 32°C (change every 12 h). When the first prosoma metameres appeared on the germ band, the embryos from experimental group were incubated at 23°C until casting the egg chorion and prelarval capsule. Hatching took place approximately 20 days after the eggs were laid. From the obtained teratological material individuals with anomalies were successively selected and photographs were taken.

Results and discussion

The mortality rate in the control group was around 5%

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but larvae with emerged from this eggs did not have any developmental abnormalities. The mortality rate among experimental embryos was around 28% and spiders in this group had various deformities of appendages (oligomely, schistomely, heterosymely).

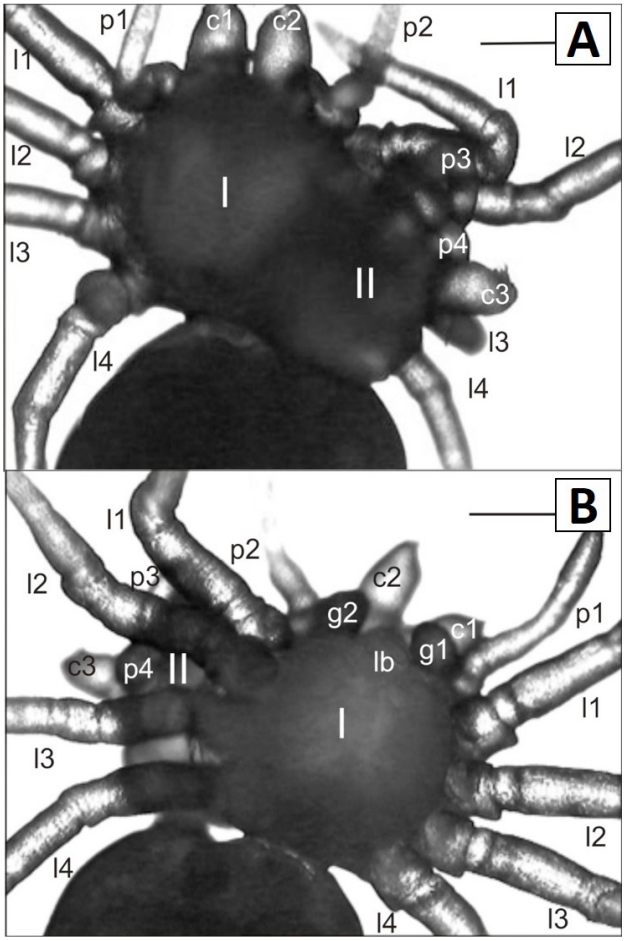

Fig. 1. *Eratigena atrica* larva: **A,** dorsal view; **B,** ventral view. I, prosoma; II, additional cephalic part; c1-c3, chelicerae; g1-g2, gnathocoxae; lb, labium; l1-l4, walking legs; p1-p4, pedipalps. Scale bar= 0.32 mm.

A particularly complex deformity of the prosoma of *Eratigena atrica* C. L. Koch, was obtained in a teratological experiment based on the application of two different temperatures changed every 12 h for the first 10 days of the spider embryonic development. Due to the nature of the deformity was classified as a unique case of bicephaly (Fig. 1). The larva had all the appendages on the prosoma (I), *i.e.* two chelicerae (ch1 and ch2), two pedipalps (p1 and p2), and four pairs of walking legs (l1-l4). However, there was an additional part (II), with appendages, which was classified as a cephalic part. It was located on the right side of the prosoma, on the dorsal side, above walking legs belonging to the second, third and fourth pairs. It covered the first segments of these three legs, making them invisible from the dorsal side. This additional cephalic part (II) was wide, massive and was fully connected with the properly developed prosoma (I). On its outer edge, facing to the right and slightly to the rear, there were the following appendages: two segmented, but relatively short pedipalps (p3, p4) with gnatocoxa, and one chelicera behind them (c3) (Fig. 1). The length and width of the base of this chelicera were comparable to the chelicerae c1 and c2, but it had two fangs. Behind the chelicera the distal edge of the head was semicircular, without appendages.

The complex deformity analyzed in this study was identified for the first time in teratological experiments using thermal shocks. Previously only Napiórkowska *et al*. (2010) described a different case of bicephaly. The uniqueness of that case lied in the fact that the affected spider had an additional, incomplete head with a well-developed pair of chelicerae and only one set of eyes. It was connected to the normally developed prosoma with a thin stem on the right side of the fovea media and was directed toward the rear.

Our observations indicate that bicephaly in spiders can have many forms. Exposure of embryos to temperature fluctuations results in individuals with two well-developed heads or with one well-developed head and one incomplete shifted to the side. It should be noted, however, that developmental deformities of this kind are extremely rare and usually lead to death of the affected individual in the early stages of postembryonic development.

We believe that there is a close relationship between temperature as a factor disturbing morphogenesis and anomaly in the front part of the prosoma. It is to be noted that temperature affects not only the embryogenesis, but also biology of invertebrates. Moreover, it determines the distribution and dynamics of entire populations (Ahmad *et al*., 2016; Elekcioglu, 2017; Khan and Naveed, 2017).

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Statement of conflict of interest

Authors have declared no conflict of interest

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