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Abnormalities in Some Odonata Larvae Which Do Not Hinder Development

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Highlights:
- Environmental change
- Stress
- Diagnostic character

Keywords:
- Odonata
- Larvae
- Abnormal body parts
- Antennae
- Labium

ABSTRACT:

Larval abnormalities in insects can be a sign of environmental changes and stress. Therefore, these abnormalities could serve as bioindicators of environmental shifts. This study examined larvae of *Onychogomphus forcipatus albotibialis* Schmidt, 1954, *Sympetrum sanguineum* (Müller, 1764), and *Platycnemis pennipes* (Pallas, 1771) species. The antennae of *O. forcipatus albotibialis* larvae displayed various deformities. Unexpected changes in the setae series in the mentum region of the labia of *S. sanguineum*, a diagnostic characteristic, were also observed. Additionally, *P. pennipes* had a deficiency in the labial palp setae. By understanding how different factors can affect larval development and how these changes can manifest in different parts of the body, the findings of the present study emphasize the importance of identifying and diagnosing these species through the images of the anomalies observed.

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INTRODUCTION

Insect larvae undergo significant changes in their physical form and behavior during development. In particular, dragonfly larvae show variable responses to the increasing impacts of climate change (Trong et al., 2021), highlighting the need to understand the impact of environmental factors on their development and survival. Congenital malformations in insect larvae can be caused by a variety of factors including exposure to hypoxia or anoxia, infection with pathogens, the social environment, chemicals, pollutants, and toxins (Ingram, 1976; Smagghe & Degheele, 1992; Tasei, 2001; Adamski & Ziemnicki, 2004; Kunz & Seidenbusch, 2006; Haq, 2012; Rodríguez-Martínez & Torralba-Burrial, 2012; Sesterhenn et al., 2013; Callier et al., 2015; Gładysz et al., 2016; Pulliainen et al., 2022).

Dragonfly larvae are sensitive to various environmental factors, including habitat degradation, land-use change, habitat structure and complexity, predation, pollution, water chemistry, and climate change (Luke et al., 2017; Mokaria & Jethva, 2019; Trong et al., 2021). Research suggests that abnormalities in larval development may be significantly influenced by the aforementioned factors.

This study examines anomalies found in larvae of *Onychogomphus forcipatus albotibialis*, *Sympetrum sanguineum*, and *Platycnemis pennipes* and discusses possible causes.

MATERIALS AND METHODS

Specimens were collected by hand scoop during fieldwork. Larvae were killed in 70% ethanol. When the specimens were brought to the laboratory, they were stored in dark colored bottles containing Oudeman liquid. The specimens were photographed with an Olympus e330 DSLR camera attached to an Olympus SZX10 microscope.

The information on the odonata specimens, which are the subject of this study, are as follows.

Onychogomphus forcipatus albotibialis: 1 specimen, Adana, Feke, Göksu river, 37°48'49.1"N 35°55'25.5"E, 563 m., 07/05/2002; 1 specimen, Muğla, Seydikemer, Demirler village, Eşen river, 36°27'27.4"N 29°19'39.2"E, 44 m., 21/04/2001; *Sympetrum sanguineum*: 1 specimen, Denizli, Bozkurt (plateau of Çambaşı, Karagöl), 37º44’N 29º29’E, 1280 m, 08/08/2000; *Platycnemis pennipes*: 1 specimen, Tokat, Niksar, Kümbetli, 27/06/2005, 40^{o} 37' N 36^{o} 48' E, 258 m.

No specimens with other congenital anomalies have been found in other collections made in the localities of the specimens in which abnormal structures were observed.

RESULTS AND DISCUSSION

In the specimen of *O. f. albotibialis* collected from Adana-Feke, the pedicellus and scapus parts of the left antennae appeared normal, but the flagellum part of the right antenna was severed (Figure 1). This is a common occurrence in predatory insect larvae. The difficulties these insects face during their development often result in damaged antennae, a crucial aspect of their natural selection process. Antennae are responsible for enabling insects to sense scents around them, which helps predatory insects locate their prey. Research has shown that damaged antennae in insects can reduce their sensing abilities. For example, Murlis et al. (2000) found that damaged antennae in male moths significant reduced their ability to detect female pheromones that are crucial for mating. Similarly, Goulson et al. (2005) found that damaged antennae in bumblebees led to a significant reduction in their ability to detect floral scents, which are essential for foraging.

Figure 1. *O. forcipatus albotibialis* antennae (from the dorsum of the head) (Adana province)

In the specimen of *O. f albotibialis* collected from Muğla-Seydikemer, the right antenna was normal, but the flagellum part of the left antenna was short due to a developmental disorder (Figure 2). This may indicate a genetic defect or the chemical effect of environmental factors. Yorulmaz et al. (2015) investigated the water quality of the Esen River in their study and focused on the effect of fish farms on river water quality. The authors mentioned that relatively high EC BOD5 NO3-N, PO4-P levels, and relatively low DO are evidence of organic pollution caused by fish farms. The average nitrite nitrogen (NO2-N) was also high in this sampling point. According to the authors, intensive fish farming decreased the ecological water quality of the river in this sampling point. Ingram (1976) demonstrated that environmental factors such as temperature and photoperiod could cause anomalies in the wing pads of larvae of different odonata species. Even small temperature changes in water temperature have been shown to cause abnormalites in larvae. The reason for the anomaly observed in this study is that the fish farms located near the specimen of *O. f albotibialis* collected from the Muğla-Seydikemer collection point adversely affect the chemistry of the water.

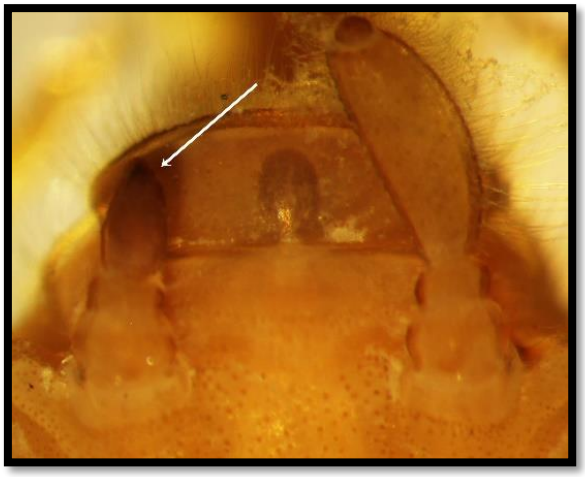

Figure 2. *O. forcipatus albotibialis* antennae (from the dorsum of the head) (Muğla province)

In the *S. sanguineum* species, it is characteristic to have long and short setae in rows on the right and left parts of the mentum of the labia. In the collected specimen, it was observed that while the arrangement of these setae was regular and normal in the right part, it was abnormal and clustered in the left part (Figure 3). This clustering goes against the diagnostic character of the species. It is worth noting that this anomaly does not pose a problem in hunting or feeding this insect, but it does cause deviation from its diagnostic character. Kunz and Seidenbusch (2006) previously stated that there is a deficiency in the left labial palp in *Sympetrum sinaiticum* larvae, and that the setae on the mask are longer in the

missing palp. Perhaps these longer setae develop successfully by giving it an advantage in feeding the larva. The anomaly caused by the hair growth in the larvae is not harmful in terms of nutrition.

Figure 3. *Sympetrum sanguineum* labium

Regarding the *P. pennipes* species, it is noteworthy that there was only one seta instead of the expected three setae in the right labial palp part of the specimen (Figure 4). The other two cetanes were observed to be congenitally deficient. Of the two lacking setae, only the basal part of one of them was formed. However, this is not significant in terms of the insect's ability to hunt or live its daily life, as in the case of *S. sanguineum*.

Figure 4. *Platycnemis pennipes* labium

CONCLUSION

The findings of the study highlight the importance of identifying and diagnosing species through the anomalies observed in their larvae. Larval abnormalities in insects can be indicative of environmental changes and stress (Ingram, 1976; Gladysz et al., 2016; Jeremiason, et al., 2016), and therefore can serve as biological indicators of environmental changes. Many factors, both internal and external, can influence larval abnormalities in insects. These factors include toxic algae, pollution, parasites and pathogens (Xiong et al., 2006). Congenital malformations in insect larvae can occur due to a variety of factors, including exposure to chemicals, pollutants and toxins, as well as exposure to insect growth regulators (Tasei, 2001; Adamski & Ziemnicki, 2004; Haq, 2012). Additionally, the diversity and

community composition of dragonflies can be influenced by a variety of factors, including habitat structure and complexity, predation, pollution and water chemistry (Luke et al., 2017; Mokaria & Jethva, 2019; Trong et al., 2021). For example, some larval anomalies detected in *Libellula quadrimaculata*, an odonate species, may be due to heavy metals, which are contaminants commonly found in water (Gladysz et al., 2016). Likewise, larval anomalies have been detected in odonates due to methylmercury contamination (Jeremiason et al., 2016).

If an evaluation is made in the light of all this information, further research is needed to fully understand the complex interactions between environmental factors and larval development in aquatic insects. Such investigations may involve investigating possible causes, such as the chemical effects of environmental factors, and identifying possible remedies to reduce or control the impact of such factors. The conservation of biodiversity is critical in addressing these concerns, and this research could provide the necessary information for the conservation of species and prevent similar concerns from arising in the future.

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Conflict of Interest

The article authors declare that there is no conflict of interest between them.

Author's Contributions

The authors declare that they have contributed equally to the article.

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