Larval Mouthpart Deformities in Chironomus annularius Meigen (Diptera: Chironomidae) from Al-Hammar Marsh, Southern Iraq & Tanjero River, Kurdistan, Northern Iraq

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INTRODUCTION

Chironomus annularius is one of the most widely distributed and frequent found species that can be used as a model organism in eco-toxicological sediment biotests (Meregalli *et al*., 2002; Nowak *et al*., 2006). *Chironomus annularius* larvae, which is usually found in lotic, organically polluted conditions (Epler, 2001), showed distinct mouthparts deformities at Al-Naggarah site, Al-Hammar Marsh, Southern Iraq and Tanjero River, Kurdistan, Northern Iraq. This is the first report of deformities in Iraqi freshwater insects, and is discussed in relation to known toxic pollutants within the catchments.

BACKGROUND

Chironomids (Diptera, Chironomidae) have been widely used as bioindicators of freshwater contamination, because of their wide distribution and sedentary lifestyle. Pollution may be assessed based on individual characteristics of chironomids (e.g. biochemical, morphological or behavioral characteristics), or chironomids may form part of some broader 'community' index.

The discovery of frequent morphological abnormalities in chironomid larvae collected from contaminated sites has given rise to numerous studies of possible relationships between deformities and contamination. There can be no doubt that deformities tend to be more frequent in more contaminated sites and many field studies have taken frequency of chironomid deformities as an indicator of the severity of contamination (Servia *et al*., 2000).

Evidence from field studies shows that mouthpart deformities in chironomid larvae are a sub-lethal response to pollution. Interest has been shown to use this end-point in programs for monitoring sediment quality. Assessing the presence of pollutants in the sediment by monitoring mouthpart deformities is more suitable than using end points such as growth and survival. This is because induction of deformities is not influenced, for instance, by food availability, whereas growth and survival may be (Vermeulen, 1995).

Notably, the tendency for deformities to arise in response to contamination varies greatly among chironomid taxa. For example, Dermott (1991) found that larvae of the genus *Procladius* tend to show fewer deformities than larvae of the genus *Chironomus* collected at the same site.

These deformities develop at the endocrine-regulated molting stage and disruption of this complex process is likely at the base of their ontogeny (Janssens de Bisthoven *et al*., 1992; Meregalli and Ollevier, 2001).

During laboratory studies, however, deformities were induced in only a few single pollutant exposures. Deformities of midge mouthparts have been used as an indicator of heavy metal contamination, agricultural, industrial, and domestic pollutants (Adamus *et al.*, 2001). In many laboratory bioassays, chironomid mouthpart deformities were clearly induced after exposure to copper (Kosalwat and Knight, 1987), DDT (Madden *et al.*, 1992), xylene (Janssens de Bisthoven *et al.*, 1997), lead and mercury (Vermeulen *et al.*, 2000).

Warwick (1985) was the first to point out the need to study not only the frequency but also the severity of deformities, as a basis for the development of more sophisticated indices of the effects of contamination on chironomid larval development. Warwick and Tisdale (1988) has suggested that the deformity responses of different head capsule structures to contamination can be described by a 'quantal dose-response' model, in which increasing concentrations of pollutants might induce shifts in the response of the different structures (i.e. from antennal deformities at low concentrations to anomalies in more heavily sclerotized parts when the concentration increases). In *C. riparius*, the deformities affected the mentum, mandibles, premandibles, antennae, epipharyngeal pecten, labral lamellae and/or labral setae. A number of studies have provided support for this view (e.g. Servia *et al.*, 2004).

Some authors have preferred to consider only mentum deformities when dealing with biomonitoring studies. Lenat (1993) has developed an index called 'Toxic Score'. He classified *Chironomus* mentum deformities into three groups: Class I, slight deformities that were difficult to distinguish from breakage or abrasions of the teeth; Class II, severe and clearly apparent deformities, including extra or missing teeth, gaps and distinct asymmetry; Class III, multiple severe deformities (including at least two Class II characteristics).

Other authors (e.g. Gutche and Urk, 1989) have reported experiments with various *Chironomus* species that indicate direct relationships between heavy metal levels and deformities in the epipharyngeal pecten.

Larval Mouthpart Deformities in Al Hammar Marsh & Tanjero River

The figure below showed the head capsule of *Chironomus annularius* collected from Al-Naggarah site, Al-Hammar Marsh, Southern Iraq on January 2006.

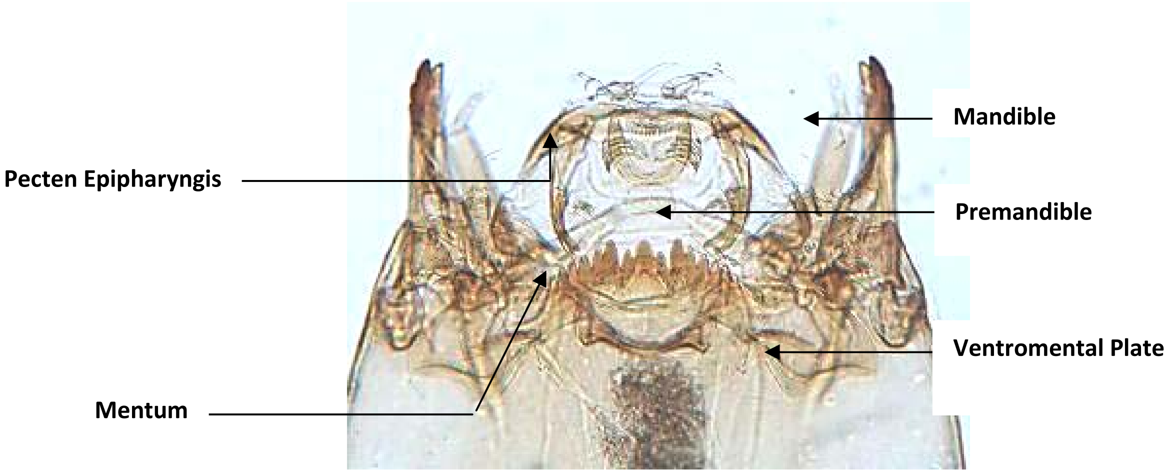

Figure 1: Mouthparts of *Chironomus annularius* larvae. Photo by Mohammed A.T. Al Saffar

Laboratory work indicates that around 300 specimens out of 500 specimens collected from Al-Naggarah site and more than 400 specimens out of 500 specimens collected from the Tanjero River, Kurdistan, Northern Iraq were suffering from mouthparts deformities. The most damaged and anomalous part in Al-Naggarah site was the Pecten Epipharyngis as shown in figure 3a and 3b. Secondarily, the Mentum also showed deformity as shown in figure 5a and 5b. The premandible was also deformed in some specimens as shown in figure 7a, 7b, and 7c. On the other hand, mandibles were not deformed when compared with the Pecten Epipharyngis and Mentum. While, Menta were the most severely deformed in the Tanjero River specimens followed by the Mandibles, Premandibles, and the Pecten Epipharyngis respectively.

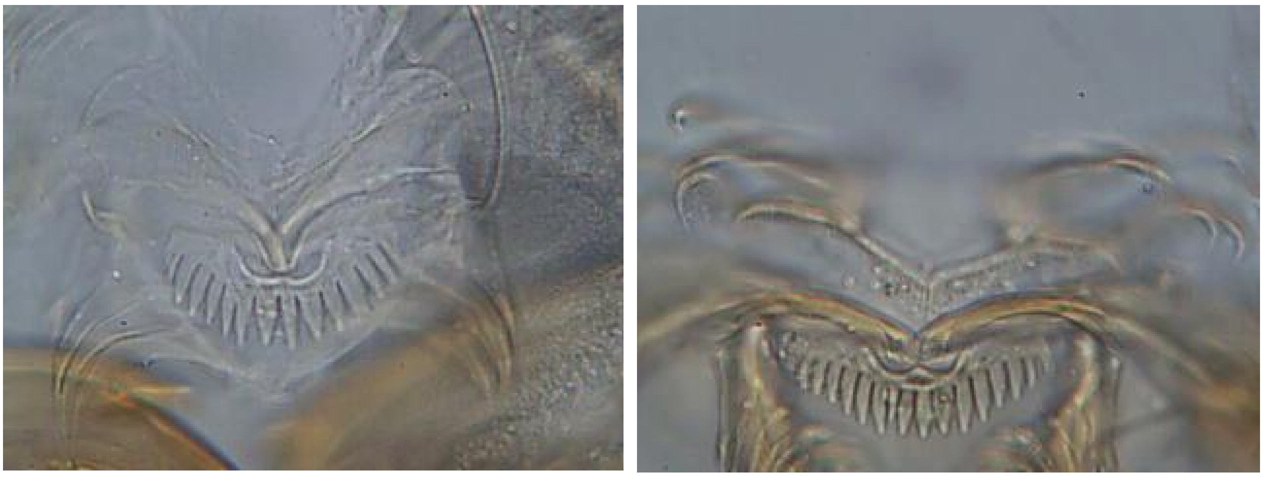

Figure 2: Normal Pecten Epipharyngis of Chironomus annularius larvae. Photos by Mohammed A.T. Al-Saffar

Figure 3a: Deformed Pecten Epipharyngis of *Chironomus annularius* larvae. Photo by Mohammed A.T. Al-Saffar

Figure 3b: Deformed Pecten Epipharyngis of *Chironomus annularius* larvae. Photo by Mohammed A.T. Al-Saffar

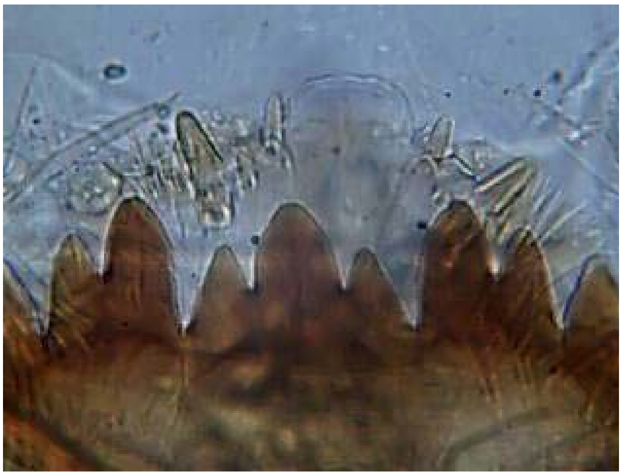

Figure 4a: Normal Mentum of *Chironomus annularius* larvae. Photo by Mohammed A.T. Al Saffar

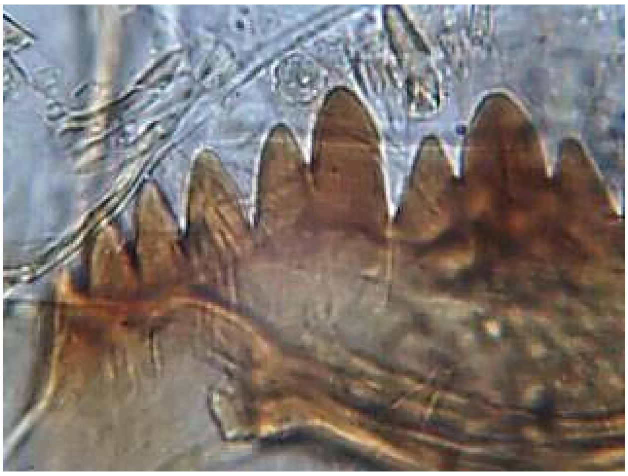

Figure 4b: Normal Mentum of *Chironomus annularius* larvae. Photo by Mohammed A.T. Al Saffar

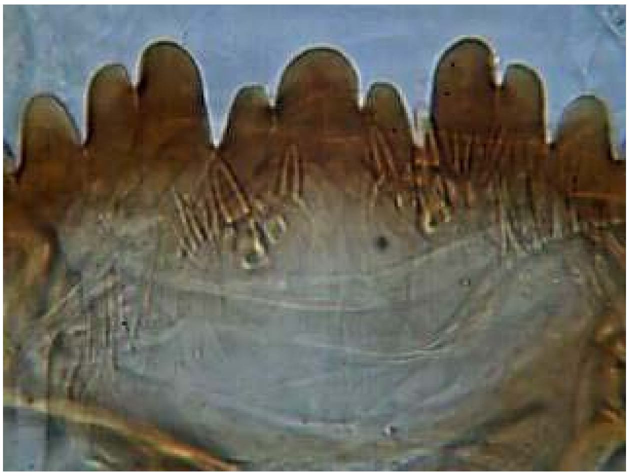

Figure 5a: Deformed Mentum of *Chironomus annularius* larvae. Photo by Mohammed A.T. Al Saffar

Figure 5b: Deformed Mentum of *Chironomus annularius* larvae. Photo by Mohammed A.T. Al Saffar

Figure 6: Normal Premandible of *Chironomus annularius* larvae. Photo by Mohammed A.T. Al Saffar

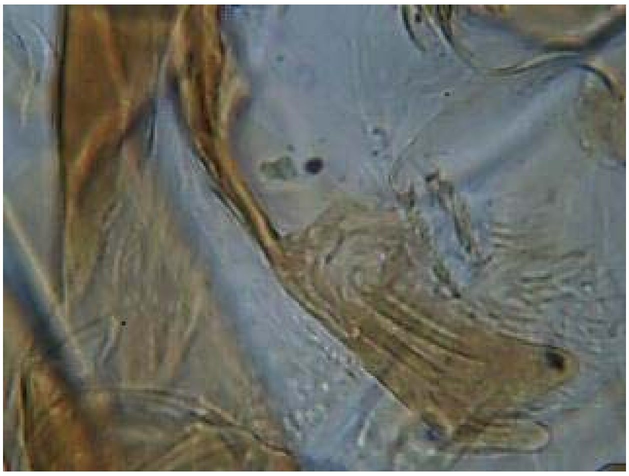

Figure 7a: Deformed Premandible of *Chironomus annularius* larvae. Photo by Mohammed A.T. Al Saffar

Figure 7b: Deformed Premandible of Chironomus annularius larvae. Photo by Mohammed A.T. Al Saffar

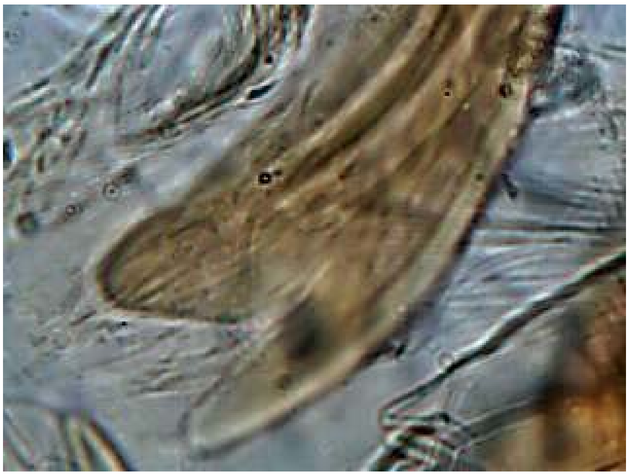

Figure 7c: Deformed Premandible of *Chironomus annularius* larvae. Photo by Mohammed A.T. Al Saffar

CONCLUSIONS & RECOMMENDATIONS

The preceding results showed a low to medium level of pollution in Al-Naggarah and medium to high pollution in the Tanjero River. This is in agreement with Vermeulen *et al.* (1998) who suggested that the different structures respond differently to increasing levels of pollution. Deformities in the pectens, menta, and mandibles can be signs of low, medium, and high levels of contamination, respectively.

The deformed Pecten Epipharyngis is possibly a result of either DDT or heavy metals (copper, lead, and mercury) contamination at these sites. DDT induced deformities are documented in the findings of Madden *et al.* (1992) and heavy metals induced deformities are in agreement with the findings of Kosalwat and Knight (1987), Gutche and Urk (1989), and Vermeulen *et al.* (2000). In addition, severity of the observed deformities is expected to increase in autumn and winter. Low temperatures during the cold season can be expected to extend the period larvae remain in contact with sediment and, consequently, these larvae will be exposed to pollutants for a longer time than larvae that develop during the summer. This is in agreement with Servia *et al.* (2000). They found that deformities are more frequent during the colder period of the year and their finding suggest that studies using chironomid larvae as indicators of contaminations should involve sampling over an extended period, to minimize the influence of temporal variation.

Therefore, we recommend the following respectively:

1. Further investigation to determine the types of agricultural, industrial, domestic, nuclear, and other pollutants in these Iraqi waterbodies.
2. Further investigation for the relationship between these pollutants and the type of the larval mouthpart deformities in *Chironomus annularius*.
3. Establishing a long term biomonitoring study for the Iraqi waterbodies using larval mouthpart deformities in *Chironomus annularius* as indicators of agricultural, industrial, domestic, nuclear, and other contaminations.

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