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THE EFFECT OF DAM CONSTRUCTION ON THE CHIRONOMIDAE (DIPTERA, NEMATOCERA) ASSEMBLAGES IN SEJENANE WADI, BIZERTE, TUNISIA

ABSTRACT

Natural running water wadis are important for ecological conditions of many organisms. Dams are built across a running water valley for multiple-purpose, therefore natural running water system is divided to three different habitats; wadi, reservoir and spillway. In order to understand the effects of dam construction on the Chironomidae dispersion, Chironomid fauna of three habitats, Sejenane wadi and its branches that flow into the reservoir, newly formed Sejenane Reservoir and spillway were investigated and compared. Even though 10 species were determined from the wadi, only two species from the reservoir and three species from the spillway were found.

Key words: Chironomidae, habitat preferences, reservoirs, wadi, Tunisia.

1. INTRODUCTION

Streams are linear systems that transfer precipitation from continental masses towards sea. The character of a stream network is influenced by the climate, relief, geological structure and age of river system. After the dam construction, a reservoir and a spillway are formed on the stream system. The hydrological regime of a reservoir is ambiguous since it is neither a lake nor a stream. Also a spillway is a discharge water system for the reservoir between dam and sea. Generally former river drainage area is used to transport the discharge water of reservoir to sea. The water level fluctuation in a spillway is irregular like a reservoir[1].

It is known that the construction of dams is an important factor that might affect ecological circumstances. It is well known that the water status is important environmental condition for aquatic organisms. After dam construction, water status of running water is changed to stagnant water in reservoir therefore, three habitats were formed (Fig. 1). In order to understand the effects of the change of water status, Chironomid fauna was chosen as study object and assemblages of three habitats were compared because Chironomids could occur almost all aquatic habitats.
Chironomidae (Diptera) are a family of small midges whose larval stage makes up over 50% of the benthic macroinvertebrate community. They are a diverse and widespread family subsisting in most climates and a wide range of water qualities[2].These characteristics make them excellent candidates in monitoring water quality in both lotic and lentic ecosystems. [3, 4]

To observe the effects of water status that was changed after dam construction, Sejenane wadi that flow into the reservoir, newly formed Kazandere reservoir and spillway were selected as study area, and chironomid assemblages of three habitats were determined and compared. The Sejenane wadi is used for irrigation of agricultural areas. Finally, this study was performed to find answers for the following questions: how were the Chironomidae assemblages influenced by change of water status due to dam construction? And which species would be able to adapt to newly formed habitat? Additionally, this is a basic study to understand the evolution of Chironomid fauna in amont and in aval of reservoir.

2. MATERIALS AND METHODS

2.1 Sampling sites

The Sejenane river, locally known as Sejenane wadi,has a catchment area of 457 Km^2 and is located in North-Eastern of Tunisia (Fig. 1). It originates in the high plains of the Tellian Atlas and flows to the North to Ichkeul Lake, after crossing the coastal plain between Sejenane and Teskreya. In 1994, within the scope of the project started to supply drinking water to Tunis and for irrigation of agricultural areas, dam were built at the stream front (Fig. 1) [5].

The climate of the Sejenane basin is typically Mediterranean, with dry, hot summer from June to September and a rainy period from October to May. Average yearly rainfall varies from 450 mm per year upstream to 735 mm per year downstream.

Sampling sites were chosen among the basin area on the basis of water permanence, with samples taken betwen May 2005 and April 2006. The positions, coordinates and altitudes of the sampling sites are indicated in Figure 1 and Appendix I chironomid larvae and pupae exuviae were collected with a Surber net (300 µm mesh size, 50 cm width) [6]. Ten samples were collected opposite to the current along the sampling station, in the middle of the current and near the banks, then merged together for the statistical analysis. It was also randomly collected larvae from submerged stones with a total surface area of 1 m^2 at each site. Adults were collected with a entomological net near a wadi banks.

2.2 Methods

The material was first preserved in 10% formaldehyde, and later transferred to 70% ethyl alcohol for sorting and final conservation. The species identification was based on imagines, pupal exuvia, and larvae. The Italian keys for larvae determination were used: Brooks et al. [7], Epler [8], Ferrarese [9], Ferrarese and Rossaro [10], Nocentini [11], Rossaro [12], Wiederholm [13], along with the keys for Palaearctic pupal exuviae : Langton [14], Langton and Visser [15], Wilson and Ruse [16] and for adult males: Langton and Pinder[17]. There are no keys for Chironomidae published from the Tunisian region. Besides Langton and Visser [15], the above-mentioned keys are from Europe, the Western Holarctic, the North Mediterranean or the whole Holarctic region and allow to identify chironomids only to genera. Thus, most of the material was identified only to the genus level or morphotypes and to the species level when possible.

Dissolved oxygen and pH values of the stations were measured at the area with portable WTW multiline P4. Substrate composition was determined as percentage of silt, sand, gravel and cobble (Table 1). Dominancy are calculated via specimen number in a group X 100 / total specimen number of all groups. Particle size distribution was estimated using the Wentworth scale [18] but approximated in 9 classes: cobble, pebbles, coarse gravel, medium gravel, fine gravel, coarse sand, medium sand, fine sand and silt. Substrate size was ranged from cobble (100%) to silt (<25%).

3. RESULTS AND DISCUSSION

The study area consists of three different habitats; wadi (amont stations), reservoir (st4, st5, st6) and spillway (aval stations) that are formed after dam construction. Materials were collected totally from nine stations. Three locations from wadi (st1, st2, st3), three locations from reservoir (st4, st5, st6), and three locations from spillway (st7, st8, st9) were investigated.

Chironomid specimen was not found in three locations (St6, and St7). Totally ten species, *Tanypus punctipennis* (Meigen, 1818); *Procladius choreus* (Meigen, 1804); *Diamesa starmachi* (Kownacki and Kownacka, 1970); *Potthastia gaedii* (Meigen, 1838); *Rheocricotopus fuscipes*; *Polypedilum nubifer* (Skuse, 1889); *Chironomus plumosus* (Linnæus, 1758); *Tanytarsus* sp. 1; *Rheotanytarsus* sp. 1 (Thienemann & Bause, 1913); *Chironomus riparius* (Meigen, 1804) were identified from seven locations at the study area (Table II). A maximum of seven species (*Tanypus punctipennis* (Meigen, 1818); *Procladius choreus* (Meigen, 1804); *Diamesa starmachi* (Kownacki and Kownacka, 1970); *Potthastia gaedii* (Meigen, 1838); *Rheocricotopus fuscipes*; *Tanytarsus* sp. 1; *Rheotanytarsus* sp. 1 (Thienemann & Bause, 1913); *Chironomus riparius* (Meigen, 1804) were found in one site of Sejenane wadi (St1). The most frequent (5 records) and dominant (35.22%) species, Chironomus riparius was recorded in the wadi, reservoir and spillway. *Diamesa starmachi*, *Potthastia gaedii* and Tanytarsus sp.1 are recorded only in the wadi. Procladius choreus, Tanypus punctipennis, Rheocricotopus fuscipes, and Rheotanytarsus sp. 1 were each foud two times. Just *Potthastia gaedii* is recorded only in one sampling site (Table II).

In the reservoir only two species, *P. nubifer* and *Ch. plumosus* were identified. *Ch.plumosus* with high dominance is common in all habitats and it was found not only in the reservoir but also in the wadi and spillway.
In the spillway, *Procladius choreus*, *Tanypus punctipennis*, *Rheocricotopus fuscipes*, *Polypedilum nubifer*, *Chironomus plumosus, Tanytarsus* sp. 1, *Rheotanytarsus* sp. 1 and *Chironomus riparius* were found, one of which (*P. nubifer*) were found only in the reservoir and spillway (Table II). Also there was not found any more species in the reservoir or spillway that are different from the wadi fauna. Wadi, reservoir and spillway are evaluated as different habitats and ecological features a.s conductivity, dissolved oxygen, pH values were measured. Conductivity were recorded a. minimum 447 µS/cm at St2 and a. maximum 4258 µS/cm at the spillway (St9). Dissolved oxygen level are recorded a. minimum 9.65 mg/L in the reservoir (St5) and a maximum 12.35 mg/L in the spillway (St8). The values of pH were recorded a minimum 6.50 at the reservoir (St5) and maximum 8.32 at the Sejenane wadi (Table I).

The species diversity of wadis is higher than Ziatine wadi but lower than Joumine and Melah wadis [19]. Three species, *P. nubifer*, *Ch. plumosus* and *Ch. riparius* were found in the reservoir. Species number of the Sejenane Reservoir is very low among other reservoirs that mentioned in former studies in Tunisia [20]. *Ch. riparius* are found in various types of water like as seasonal water holes, lakes and rivers. Also the species are dominant and it is the only species not affected by habitual change in the wadi basin, it could be said that *Ch.riparius* has high adaptation ability. The second species is *Ch. plumosus*.

Generally it found in ponds, littoral zone of lakes, streams, canals and ditches. Its distribution is generally in North Africa [21, 19, 22] and Europe [23]. According to Chaib et al. [21], the midge communities in North Algeria also differ according to the sediment structure. This works have pointed out that in the North African water systems, hard substrate (e.g. cobbles) (St1, St2, St3, St8) offers suitable conditions (interstitial space to survive a low water level and accumulate organic matter, a substructure for peryphiton) for midge larvae. In the Algerian river systems, chironomid fauna is more diverse in hard bottomed streams. In wadis, where fine and ultrafine mineral fractions dominate (St5, St9), the current is usually strong while a compacted bottom fraction does not provide larvae with shelter when discharge is high or during habitat desiccation.

Lower transparency and low concentration of dissolved oxygen favor more resistant species. Chaib *et al.* [21] have proved that seasonality plays a fundamental role in the composition of Chironomidae communities in the southern Mediterranean region. They have concluded that harsh conditions in North-African wadis require resistance to disappearance of suitable habitats, high temperature and lentic conditions. Our study in Sejenane wadi indicate that, in fact, lowland flowing waters are inhabited mainly by eurytopic taxa (*Ch. plumosus, Ch. riparius, P. nubeculosum*) while in highland wadis many rheophilous, stenotopic species, requiring good water quality, such as *Potthastia gaedii, Tanypus punctipennis, Rheocricotopus fuscipes.*

Besides these conditions is added activity opening and closing of the dam by changing the speed of the water (absence of species in the station 6 and 7), the upstream and downstream granulometry and the influence of salinity select chironomid fauna in the studied stations. species richness degrades upstream of the wadi (St1, St2, St3) to the reservoir. Only the most eurytopic species persists in the reservoir. Species richness is reconstituted in the spillway (St8, St9) as the habitat becomes more stable with constant physicochemical parameters.

Ch.plumosus, Ch.riparius and P.nubifer were found in the spillway. Therefore, this three species tolerates a wide range of environmental conditions and prefers both large and small permanent water bodies [21, 22, 19, 24]. When the ecological parameters of habitats were compared (Table I), water conductivity of the inning water (streams and spillway) showed considerable variability (447 - 4258 µS/cm). The highest rates of conductivity were measured in the spillway (St8, St9). High level conductivity is indicate the "salty water" that is possible for spillway that close contact with Ichkeul lake. In contrast to wadi, conductivity values of the reservoir did not have variability (938

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µS/cm). The other important ecological parameter is dissolved oxygen. The oxygen levels in the wadi is between 10.66 and 11.09 mg/L, in the reservoir between 9.65 and 9.78 mg/L and in the spillway between 10.56 and 12.35 mg/L. Dissolved oxygen level of the running water (wadi and spillway) was higher than reservoir (stagnant water) and that is in accordance with our knowledge. In addition the ecological parameters same differs among the habitats like as water status and water flow regime are important.

4. CONCLUSION

Water status are changed from running water to stagnant water bodies in reservoir and water flow regime are irregular in the spillway. Finally, dispersion of Chironomids species in the Sejenane Basin is negative affected by the construction of the dam. The variations of ecological features allow species diversity and richness, but according to the present study, not only ecological parameters but also water status is effective factor for Chironomid dispersion. Chironomid fauna of the reservoir will be shaped in the future. However, the natural fauna could be lost when the drainage area of the wadi is damaged.

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Table I. The Codes and the physicochemical parameters of the study area are showed. C: Conductivity (µS/cm); DO, Dissolved oxygen (mg/L); Tw, Water temperature (ºC) and type of substrate: Bl - Blocks, Gl - Pebbles, Gr - gravel, Sg - sand, Li - silt, Ar - clay, V - vase).

Sampling sites	Code	Coordinates	Date	DO (mg/L)	C (µS/cm)	pH	Tw (ºC)	Substrate
Wadi	St1	37°08'10.446"N 9°23'14.228"E	17.09.2005	10.70	452	8.02	22	Bl. + Sg. + Gl.
	St2	37°08'13.402"N 9°24'23.502"E	30.04.2006	10.66	447	8.32	17	Bl. + Sg. + Gl. + Ar.
	St3	37°08'56.752"N 9°25'25.3"E	04.05.2006	11.09	689	7.89	15.5	Gl. + Sg. + Ar.
Reservoir	St4	37°09'50.929"N 9°26'24.626"E	13.06.2006	9.72	938	7.56	23	V. + Gr. + Ar. + Li.
	St5	37°10'32.294"N 9°27'14.065"E	13.06.2006	9.65	938	6.25	26	V. + Gr. + Ar. + Li.
	St6	37°10'53.959"N 9°28'07.211"E	13.06.2006	9.78	938	6.33	25	V. + Gr. + Ar. + Li.
Spillway	St7	37°10'57.897"N 9°28'38.11"E	28.04.2006	12.1	1436	7.02	16	Sg. + V.
	St8	37°11'55.004"N 9°32'25.527"E	28.04.2006	12.35	2022	7.01	17	Sg. + Li. + V. + Gr. + Bl.
	St9	37°10'39.187"N 9°36'42.607"E	28.04.2006	10.56	4258	7.05	17.8	V. + Ar. + Li.

Table II. Distribution of species at the study area. n, number of specimens; D, dominance.

Species/Site	Wadi			Reservoir			Spillway				
	St1	St2	St3	St4	St5	St6	St7	St8	St9	n	D%
Diamesa starmachi (Kownacki and Kownacka, 1970)	*		*							4	1,74
Potthastia gaedii (Meigen, 1838)	*									5	2,17
Procladius choreus (Meigen, 1804)	*		*					*	*	4	1,74
Tanypus punctipennis (Meigen, 1818)	*	*							*	25	10,87
Rheocricotopus fuscipes	*		*					*	*	8	3,48
Polypedilum nubifer (Skuse, 1889)				*				*	*	8	3,48
Chironomus plumosus (Linnæus, 1758)			*		*			*	*	76	33,04
Tanytarsus sp. 1	*	*								10	4,35
Rheotanytarsus sp. 1 (Thienemann & Bause, 1913)		*							*	9	3,91
Chironomus riparius (Meigen, 1804)	*	*	*		*			*		81	35,22
total specimens number										230	
total species number	7	4	5	1	2	0	0	5	6	30	

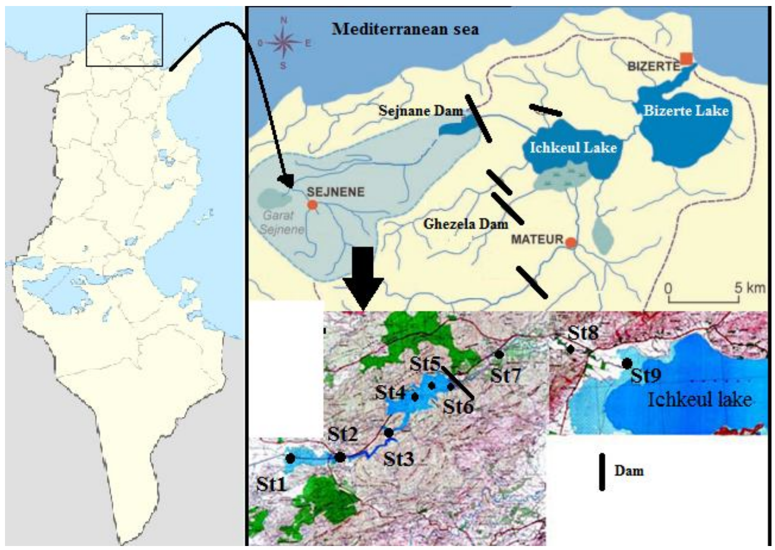

Figure 1. Geographical location of the study stations.

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