AQUATIC TRUE BUGS (HETEROPTERA: NEPOMORPHA) FROM THE URBAN SECTOR OF THE FRANCOLÍ RIVER (TARRAGONA, SPAIN)

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The Francolí river from north-eastern Spain was investigated in order to establish if the local flood prevention system is affecting the diversity of aquatic species. Aquatic and semiaquatic bugs were used as target group, since they are amongst the most resilient and adaptable aquatic invertebrates. Three different sectors were identified: one with a quasi-natural regime, an embanked sector crossing the urban area and an area close to the harbor facilities of Tarragona. Species richness declined when approaching the embanked area, where no aquatic or semi-aquatic bugs were found. The main causes were established to be the increase of water current velocity, the changes in aquatic vegetation and the lack of shore vegetation, the absence of shade, and the rapid drainage of water in the meadow area, all caused by the flood prevention system.

Key words: Aquatic and semi-aquatic bugs, embankment, Francolí River, Spain.

INTRODUCTION

Aquatic and semiaquatic true bugs, or Infraorder Nepomorpha (Aukema, 2013) are a relatively small, polyphyletic group, comprising species with usually wide ecological tolerances (Andersen, 1982; Jansson, 1986; Olosutean & Ilie, 2010 a). Some species are pioneers of newly formed aquatic habitats (Bloechl *et al.*, 2010), and most of them seem to tolerate moderate or even high levels of organic and mineral pollution (Savage, 1989, 1994; Nummelin *et al.*, 1998; Wollman, 2000; Olosutean & Ilie, 2010 c), and are even favored by mild anthropic impact (Wollmann, 2000; Olosutean & Ilie, 2010 b).

Although found in all types of water bodies, they prefer stagnant or slow flowing waters, with a consistent presence of aquatic and semiaquatic vegetation, and are not favored by high water velocity or by meadows with rapid drainage of temporary pond water (Karaouazas & Gritzalis, 2006; Nosek *et al.*, 2007; Skern *et al.*, 2010; Ilie & Olosutean, 2012, 2013).

They seem to prefer their own micro-niche inside favorable habitats (Andersen, 1982; Karaouazas & Gritsalis, 2006; Skern *et al.*, 2010), although the most common species are eurivalent and are found in a large variety of habitats (Andersen, 1982; Olosutean & Ilie, 2010 c).

The aim of the study was to establish if and how the construction of the flood prevention system by the Tarragona municipality influences the aquatic and semi-aquatic true bugs community.

MATERIAL AND METHODS

STUDY AREA AND SAMPLINGS

The investigated area is located in the North-Eastern part of Spain, in the Tarragona Province, part of the Catalonia Region. The Francolí River is the largest water body from the area, with the springs in the nearby Prades Mountains and with a typical Mediterranean flowing regime, with high waters at heavy rains and frequent flooding. In order to avoid economic losses in the urban area, the municipality of Tarragona constructed a flood prevention system, consisting of strong limestone embankments and drainage canals for over-flooding waters in the river meadows.

Biological material was sampled in a single campaign investigating aquatic and semiaquatic true bugs in June 2013, from seven sampling stations inside the administrative boundaries of Tarragona, encoded: T1 (41˚07’23.86’’ N; 01˚13’57,35” E), T2 (41˚07’18,41”N; 01˚14’03,16”E), T3 (41˚07’11,87” N; 01˚14’07,75” E), T4 (41˚07’01,93” N; 01˚14’10,93” E), T5 (41˚06’51,21” N; 01˚14’13,19” E), T6 (41˚06’41,63” N; 01˚14’15,41” E) and T7 (41˚06’34,30” N; 01˚14’14,98” E). (Table 1). All samples were similar, consisting of a 45 minutes sampling session, in order to provide quantitative data, covering all aspects of the investigated habitats (open water, shores with and without vegetation, areas with submerged and floating vegetation, etc.).

An 1000 cm^2 entomological net with 2 mm meshes was used in collecting the samples, which were preserved in 70% ethanol prior to identification. Species determination was based on Andersen (1993, 1996) and Davideanu (1999).

Table 1

Habitat characteristics of the sampling stations

Station	Elevation	Habitat
T1	8 m	quasi-natural sector, with heterogeneous substrate (sand, cobble and boulders), riverside coppice on the shores and 65-75% shaded areas
T2	6 m	quasi-natural sector, with heterogeneous substrate (sand, cobble and boulders), riverside coppice on the shores and 65-75% shaded areas
T3	4 m	the entrance in the embanked area, with a more homogeneous substrate (mostly pebble) and shore sectors with natural dynamics and patches of riverside coppice
T4	4 m	embanked sector, with homogeneous substrate (pebble), high water velocity and no shoreline vegetation
T5	3 m	embanked sector, with homogeneous substrate (pebble), high water velocity and no shoreline vegetation
T6	1 m	the entrance in the harbor area, again with homogeneous substrate (pebble), high water velocity and no shoreline vegetation
T7	0 m	harbor facilities; artificial course, embanked, with homogeneous substrate (pebbles), low water velocity and no shoreline vegetation

RESULTS AND DISCUSSION

HABITAT CHARACTERISTICS

The field survey pointed out that, considering the characteristics of the habitats investigated, three different sectors are identifiable in the Francolí River sector crossing the Tarragona administrative area (Fig. 1).

The westernmost sector is still keeping the natural regime of the river, with heterogeneous substrate and riparian vegetation represented by a compact river coppice, providing shade and organic detritus (Fig. 2a). This sector is crossing the peripheral area of the city, where the constructions are placed only on the left side of the river, on the river terraces, and the river meadow is not included in the urban planning.

At the entrance in the urban nucleus, embankments are beginning to be present, although not on the entire shoreline area (Fig. 2 b). Some shore sectors are still preserving their natural regime, as well as fragments of the coppice, and pools from the embankment constructions are still present (Fig. 2 c).

The second and the largest sector is completely embanked with limestone blocks (Fig. 2 d), with a constant width of the river and with a meadow area arranged for promenade and tourism. Not a single tree is present in this area and drainage canals are constructed for rapid discharge of waters on high river levels (Fig. 2 e).

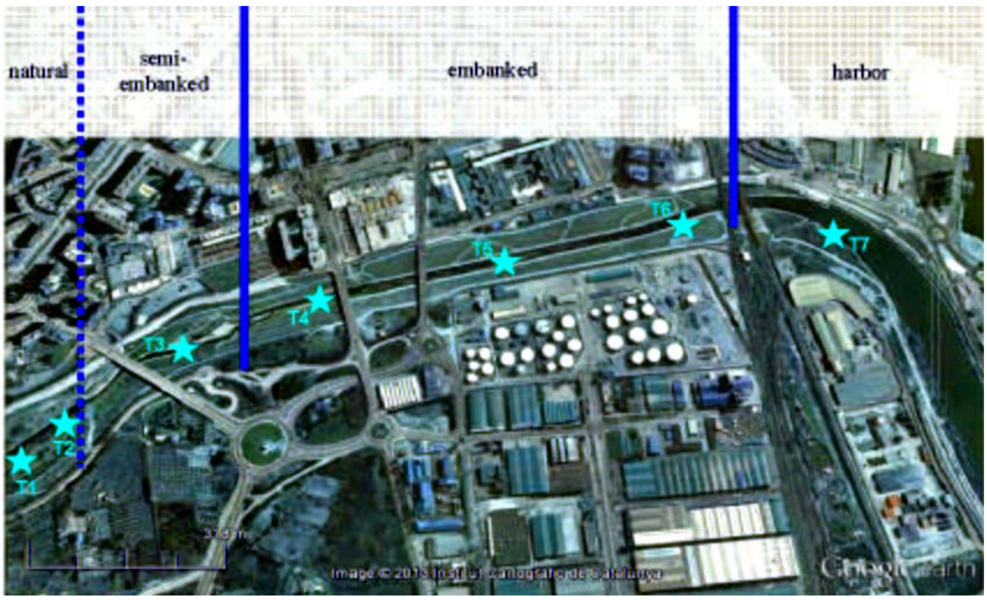

Fig. 1. The Francolí River inside the Tarragona city area, with the location of the sampling stations and the structure of the investigated habitats.

Fig. 2. Different aspects of the Francolí River
a) quasi-natural sector; b) partial embankments at the entrance in the urban area; c) stagnant areas at the river shores as a result of embankment construction; d) completely embanked sector; e) drainage constructions in the river meadows; f) the entrance in the harbor area, with strong embankments.

The third and last sector of the river is transformed by harbor facilities that enclosed the former river estuary and prolonged the river course by more than 1 kilometer towards south. Water salinity is progressively increasing in this sector, due to retentions of tide water caused by the modified river course, and the sector is also consistently embanked and lacks riparian vegetation (Fig. 2 f).

SPECIES DIVERSITY

Only four species of aquatic true bugs were found in the chosen sampling area (Table 2). The species were found only in the habitats preserving, at least partially, the natural dynamics of the river banks.

Interpolated values of both diversity indices used in the analysis show constant values in the quasi-natural sector of the river, followed by a decrease in the semi-embanked area, and by minimum values in the completely embanked sector and in the sector occupied by harbor facilities (Fig. 8).

Table 2

List and presence of the species sampled values from the investigated habitats

Species	**Sampling station**						
	T1	**T2**	**T3**	**T4**	**T4**	**T6**	**T7**
Aquarius paludum (Fabricius, 1794)	3	1	1	-	-	-	-
Micronecta (Dichaetonecta) scholtzi (Fieber, 1860)	9	5	-	-	-	-	-
Notonecta (Notonecta) glauca Linnaeus, 1758	3	3	1	-	-	-	-
Ilyocoris cimicoides cimicoides (Linnaeus, 1758)	3	1	-	-	-	-	-
Species Richness	4	4	2	0	0	0	0

The decrease in community diversity is caused by anthropic constructions in the second and third sector of the river, causing important changes in the hydro-morphological features of the watershed and meadows, making it unsuitable for aquatic and semi-aquatic bugs.

POSSIBLE CAUSES OF AQUATIC AND SEMI-AQUATIC BUG DECLINE

Several factors might be responsible for the decline of aquatic and semi-aquatic bugs in the embanked/harbor area. We can mention here *the high current velocity* created by the channel-like appearance of the river, with constant width and steep shores, and by *the quick drainage of surplus waters*, drainage that also leads to the absence of temporary and permanent ponds in the river meadow, ponds that are highly important as breeding sites for the aquatic and semi-aquatic Heteroptera; *the changes in aquatic vegetation communities*, where thick layers of filamentous algae (Fig. 3) are replacing aquatic and semi-aquatic vegetation, which offers shelter and food source for some of the species belonging to the group; *the conformation of the banks*, very steep and, therefore, lacking hygrophilous vegetation, an important factor for semi-aquatic bugs species, where they shelter, reproduce and conduct their foraging campaigns; and *the absence of shade*, not a mandatory factor for aquatic and semi-aquatic bug communities, but documented as preferred by some species.

Fig. 3. Decaying cluster of filamentous algae.

CONCLUSIONS

The aquatic and semi-aquatic true bugs community from the Tarragona sector of the Francolí River was affected by the construction of the flood prevention system by the local municipality.

There are no previous studies made on the true bugs from this particular river, so a comparison with a pre-embankment period is not possible. In the case of the Francolí River, they seem to be restrained to the sector less affected by flood protection works.

Besides the impact in aquatic diversity, the flood prevention system proved to be also ineffective at high water level (Alfieri *et al*., 2011) and the implementation of such systems should be well documented for future constructions.

REFERENCES

ALFIERI, L., VELASCO D., THIELEN J., 2011, *Flash flood detection through a multi-stage probabilistic warning system for heavy precipitation events*. Advances in Geosciences, **29**: 69-75.

ANDERSEN N.M., 1982, *The semiaquatic bugs (Hemiptera, Gerromorpha). Phylogeny, adaptations, biogeography and classification*. Scandinavian Science Press Ltd., Copenhagen, 455 pp.

ANDERSEN N.M., 1993, *Classification, phylogeny, and zoogeography of the pond skater genus Gerris Fabricius (Hemiptera: Gerridae)*. Canadian Journal of Zoology, **71**: 2473-2508.

ANDERSEN N..M., 1996, *Heteroptera Gerromorpha, Semiaquatic Bugs*. Pp. 77-91: *In* Nilsson A.N. (Ed.) *Aquatic insects of North Europe – a taxonomic handbook*. Apollo Books, Steenstrup.

AUKEMA B., 2013, *Fauna Europaea: Heteroptera, Nepomorpha.* Fauna Europaea version 2.6, Available at: http://www.faunaeur.org.

BLOECHL A., KOENEMANN S., PHILIPPI B., MELBER A., 2010, *Abundance, diversity and succession of aquatic Coleoptera and Heteroptera in a cluster of artificial ponds in the North German lowlands*. Limnologica, **40** (3): 215-225.

DAVIDEANU A., 1999, *Contribuţii la studiul Heteropterelor acvatice din România*. Ph .D. dissertation. Babeş-Bolyai University of Cluj-Napoca, Faculty of Biology and Geology, 257 pp. (in Romanian).

ILIE D.M., OLOSUTEAN H., 2012, *Aquatic and semi aquatic Heteroptera communities from south-east Transylvanian small rivers*. Travaux du Muséum National d'Histoire Naturelle "Grigore Antipa", **55** (2): 207–216.

ILIE D.M., OLOSUTEAN H., 2013, *Structure and seasonal dynamics of water bugs communities (Heteroptera: Nepomorpha) in anthropic and natural ponds from south-eastern Transylvania: the role of vegetation and water supply*. Pp.: 213-219. *In*: Marascu-Klein V., Panaitescu F.V., Panaitescu M. (Eds.), *Advances in Environment, Ecosystems and Sustainable Tourism*. WSEAS Press, Braşov.

JANSSON A., 1986, *The Corixidae (Heteroptera) of Europe and some adjacent regions*. Entomological Society of Finland, Helsinki, 94 pp.

KARAOUZAS I., GRITSALIS K.C., 2006, *Local and regional factors determining aquatic and semi-aquatic bug (Heteroptera) assemblages in rivers and streams of Greece.* Hydrobiologia, **573**: 199–212.

NOSEK J.N, VÁSÁRHELI T., BAKONYI T., OERTEL N., 2007, *Spatial pattern of waterbugs (Gerromorpha, Nepomorpha) at different scales in the Szigetköz (Hungary)*. Biologia, **62** (3): 345-350.

NUMMELIN M., LODENIUS M., TULISALO E., 1998, *Water striders (Heteroptera, Gerridae) as bioindicators of heavy metal pollution*. Entomologica Fennica, **8**: 185-191.

OLOSUTEAN H., ILIE D.M., 2010 a, *Aquatic and semiaquatic Heteroptera (Nepomorpha) from the Sulina-Sf. Gheorghe Canal (Danube Delta, Romania)*. Transylvanian Review of Systematical and Ecological Research, **10**: 55-76.

OLOSUTEAN H., ILIE D.M., 2010 b, *Influence of anthropic impact on aquatic and semi aquatic Heteroptera distribution from Repede River (Rodna Mountains National Park)*. Transylvanian Review of Systematical and Ecological Research, **9**: 149-158.

OLOSUTEAN H., ILIE D.M., 2010 c, *Relationships between habitat characteristics and aquatic and semi aquatic Heteroptera community structure in Romanian mountainous regions: a preliminary report*. Romanian Journal of Biology -Zoology, **55** (2): 139-148.

SAVAGE A.A., 1989, *Adults of the British aquatic Hemiptera Heteroptera – a key with ecological notes*. Freshwater Biological Association, Ambleside, 173 pp.

SAVAGE A.A., 1994, *The distribution of Corixidae in relation to the water quality of British lakes: a monitoring model*. Freshwater Forum, **4** (1): 32-61.

SKERN M., ZWEIMÜLLER I., SCHIEMER F., 2010, *Aquatic Heteroptera as indicators for terrestrialisation of floodplain habitats*. Limnologica, **40** (3): 241-250.

WOLLMANN K., 2000, *Corixidae (Hemiptera, Heteroptera) in acidic mining lakes with pH 3 in Lusatia, Germany*. Hydrobiologia, **433**: 181-183.

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