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# Larval habitat of sea lamprey *Petromyzon marinus* Linnaeus, 1758

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Lamprey population assessments are usually focused on sampling patches of larval habitat and in some cases differentiating between optimal and suboptimal habitat (Moser et al., 2007; Harvey et al., 2010). However, most studies concerning the description of larval habitat give a special attention to the granulometric analysis of the sediment, without precisely determining optimal habitat conditions for other variables (Harvey et al., 2010). Therefore, the aim of this study was to investigate the conditions (of a wide range of abiotic variables) that characterize the larval habitat of Sea lamprey *Petromyzon marinus* Linnaeus, 1758.

Surveys were carried out annually (2007-2011) in 31 locations situated in nine rivers in NW Spain: Anllóns, Eo, Lérez, Mandeo, Masma, Mera, Sar, Ulla and Umia. At each location ammocoetes were sampled using the single pass electrofishing method described by Silva et al. (2014) and anaesthetised using a solution of benzocaine (0.3 ml l−1). All individuals were measured (±1 mm), weighed (±1 g) and released again in the point of capture. A total of 48 variables, 9 hydromorphologic (at a basin scale), and 18 mesologic and 21 water quality parameters (meso and microhabitat scale), were collected to research the relation between these abiotic parameters and the larval density and biomass of *P. marinus*: river mouth orientation, river slope, basin area, annual module, basin length, elongation index, compactation index, coefficient of irregularity, sinuosity index, river width, discharge, shape index of the cross sec-

tion of the river, depth of the substrate, depth over the substrate, current velocity over the larval habitat and in the river section, distance to river mouth, vegetation cover, five granulometric fractions, mean and maximum depth of the water column in the river section, index of organic pollution, saturation rate of oxygen, dissolved oxygen, total dissolved solids, suspended solids, organic matter in the water, organic matter in the sediment, orthophosphates, nitrites, nitrates, ammonium, sulphates, turbidity, conductivity, pH, Calcium, Magnesium, hardness and chlorophyll a.

Spearman's rho ($r_s$) was used to investigate the relation between abiotic variables and the density and biomass of lamprey as data did not conform to normality. Larval density and biomass were classified as: very high, high, moderate, poor or very poor following Silva et al. (2014). Abiotic characteristics were analyzed for all sites where lamprey were captured (suitable larval habitat), sites with high or very high densities or biomasses (optimal habitat) and for sites with very poor, poor or moderate densities and biomasses (suboptimal habitat). Statistical analyses were performed with IBM SPSS Statistics 20.0.

A total of 8716 lamprey were captured (8338 larvae and 378 metamorphosing individuals). Significant correlations were obtained between the larval density and biomass and the section slope ($r_s$= 0.407, $p < 0.05$ for density; $r_s$= 0.434, $p < 0.01$ for biomass) and the sinuosity index ($r_s$= 0.387, $p < 0.05$ for biomass). Significant correlations were also obtained with mesologic and physicochemical parameters (Table 1). Similar correlations were obtained for sites with high or very high larval densities or biomasses (optimal larval habitat).

Larger basins with sinuous and productive rivers hosted more abundant populations of ammocoetes, probably linked with a greater availability of food and suitable spawning and larval habitats. Areas with some organic enrichment were also favourable for ammocoetes due to the greater availability of food (Moss, 1980). However, ammocoetes were not present or were in very low densities-biomasses in areas with chronic organic pollution. The optimal habitat was constituted mainly by sand located in shallow areas (~30 cm depth) with mild organic enrichment, slow to moderate water flows (~8 cm s-1) and a good-acceptable oxygen saturation rate (>70%).

In situ differentiation between optimal and suboptimal larval habitat in population studies is not recommended, due to a large number of variables involved and the difficulty or impossibility to properly characterize them on field. It is recommended to conduct the sampling in the existing patch -or patches- of larval habitat in the selected section of river that better matches the optimal conditions.

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**TABLE 1**. Significant correlations (Spearman's rho) obtained among physicochemical or mesologic parameters and the larval density or biomass. *: $p < 0.05$; **: $p < 0.01$. TDS: total dissolved solids; F.: granulometric fraction.

| Parameters | Density | Biomass |
|---|---|---|
| Mean depth | -0.304 | -0.339* |
| pH | 0.217* | 0.214* |
| Conductivity | 0.225* | 0.238** |
| TDS | 0.217* | 0.231* |
| Hardness [$CaCO_3$] | 0.291** | 0.288** |
| Ca++ | 0.281** | 0.279** |
| Mg++ | 0.244* | 0.205* |
| Nitrates | -0.179 | -0.206* |
| Amonium | -0.241* | -0.196* |
| Orthophosphates | -0.276** | -0.260** |
| F. [>2 mm] | 0.257 | 0.506** |
| F. [1-2 mm] | 0.160 | 0.373** |
| F. [0.25-0.5 mm] | -0.095 | -0.331* |
| F. [0.125-0.25 mm] | -0.295* | -0.501** |
| F. [0.063-0.125 mm] | -0.283* | -0.458** |
| F. [<0.063 mm] | -0.253 | -0.438** |