

## A keystone link between two critically endangered species in European rivers: the giant freshwater pearl mussel (*Margaritifera auricularia*) and the European sea sturgeon (*Acipenser sturio*)



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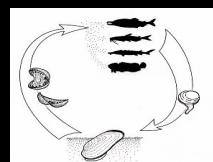


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### INTRODUCTION

The Ebro River is one of the **last known strongholds** of *M. auricularia*, where it maintains a viable population. This is a large naiad, with a thick and sturdy shell reaching over 18 cm in length and 0.6 Kg in weight. It may attain an extreme old age with some records of animals exceeding the century.



As all unionoids, its life cycle includes a larval stage that is parasitic on the epithelium of fishes; in margaritiferids, a minute glochidium able to grasp only gill filaments. Until now, four fish species have been identified as hosts for *M. auricularia* from laboratory tests: the freshwater *Salaria fluviatilis*, *Gambusia holbrooki* and two sturgeons *Acipenser baerii* and *A. naccarii*, the latter three exotic to the Ebro River.

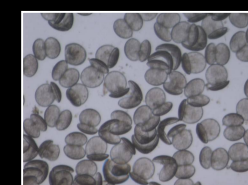
On the basis of **coincident ecological and biogeographical ranges**, as well as parallel historical declines, Altaba (1990) hypothesized that the European sea sturgeon would have been a major host and disperser of *M. auricularia*. The last population of this large, long-lived fish is now very small and restricted to the Gironde-Dordogne-Garonne system in Southwest France.



Once abundant in all big rivers throughout Western Europe, it has suffered a precipitous decline parallel to that of the giant pearl mussel, due to a combination of impacts focused on their habitat and overexploitation. As a result, these two species survive distant from each other in relatively unspoiled refugia. The hypothesis that *A. sturio* had been the major hosts of *M. auricularia* have not been able to be tested until now, due to problems inherent in working simultaneously with two species at the brink of extinction. The **objective** of this work was to test this hypothesis.

### MATERIAL AND METHODS

A total of 57 adult breeding individuals of *M. auricularia* were collected in the Ebro, from lower reaches in Catalonia, and from the Canal Imperial, a major artificial waterway along the middle course in Aragón. All mussels were kept in closed-freshwater-system facilities at IRTA's Aquaculture Centre. During the spawning season (late March to May), glochidia were obtained by pipetting through the exhalant aperture, or siphoning the bottom of tanks. The glochidia were transported in cooled isothermal containers at 8 °C, during a 24-h trip to the CREA (Cemagref, SW France).



At the CREA, glochidia were acclimated to 18 °C and local water conditions (418  $\mu\text{S}\cdot\text{cm}^{-1}$ ; 80 %  $\text{O}_2$ ). An aliquot of 108 active glochidia per mL was prepared for infection purposes. Two sturgeons (90 cm TL – 3 kg, 100 cm – 5 kg) were infested. This dose is considered as harmless for sturgeons. From 19 to 45 days post-infection the tank was regularly siphoned to collect giant pearl mussel juveniles. Recovered juveniles were measured and photographed with the binocular microscope and preserved in neutral buffered formalin.

### RESULTS AND DISCUSSION

**Seventeen juveniles of *M. auricularia* were recovered**, all between 19-39 days post-infestation. Thirteen live juvenile pearl mussels were recovered between 31 and 39 days post-infestation. In addition, 3 empty post-metamorphic shells were obtained. Mean length of all juveniles upon release was 146  $\mu\text{m}$  (SD  $\pm$  6). Most exhibited noticeable post-metamorphic growth, accounting for an average 22 % increase, and a maximum of 51 %.

Days post-infection	Live juveniles	Empty juvenile shells	Partially metamorphosed shells	TOTAL
19	-	1	-	1
25	-	-	1	1
31	7	1	-	8
39	6	1	-	7
45	-	-	-	0
<b>TOTAL</b>	<b>13</b>	<b>3</b>	<b>1</b>	<b>17</b>

The recovery of live juveniles from induced infestations is confirmation that a fish species can host that naiad; thus, such experiments are suitable to recognize non-hosts and identify putative hosts. In field conditions, a more complex response may be expected, perhaps rendering putative hosts unsuitable due to ecological factors. However, under circumstances where there is an overlap in geographic and ecological range between host fish and parasitic glochidia, it is most likely that the fish species contributes to the reproduction and dispersal of the naiad populations. This situation was well accomplished in historical times for *A. sturio* and *M. auricularia*, two species formerly dominant in large rivers of the Western Palearctic.

Our results strongly support the hypothesis of a reproductive relationship in natural environments and historical times between the European sea sturgeon and the giant freshwater pearl mussel. The role of the freshwater blenny as an alternative host has prevented the extinction of this unionoid long after the virtual extirpation of *A. sturio* in the Ebro River. In the Garonne-Dordogne system where *A. sturio* still occurs, relevant pearl mussel populations have been recently discovered. A reasonable hypothesis is that the almost complete extinction of *M. auricularia*, which started perhaps in Roman times, could have been fostered by the previous extirpation of most populations of *A. sturio*. Based on our results, we strongly suggest that **recovery programs for both species should be linked, based on joint conservation and management guidelines.**



### Acknowledgments

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