

What can we learn from regional museum collections? A reconstruction of historical distribution of the endangered Giant Freshwater Pearl Mussel *Pseudunio auricularius* (Spengler, 1793) in France

*Que pouvons-nous apprendre des collections des musées régionaux ? Une reconstruction de la répartition historique de la Grande mulette *Pseudunio auricularius* (Spengler, 1793) en France*

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Summary: The Giant Freshwater Pearl Mussel *Pseudunio auricularius* is highly endangered. It has become so rare during the XXth century that it is difficult today to assess its original distribution. In this study, we investigated the collections of 61 regional museums and universities in France. 50 had specimens of *Pseudunio auricularius*, out of which 358 specimens could be localized to at least a portion of a river or a nearby town. Five localities were previously unknown and the amount of data collected per river or drainage was very different from what was known from the literature. Following this study, extensive surveys were performed using a team of scuba divers. This resulted in the discovery of shells and an overlooked population in a drainage that had been surveyed extensively a few years earlier.

Résumé : La grande mulette *Pseudunio auricularius* est grandement en péril. Elle est devenue si rare au cours du XX^e siècle qu'il est difficile aujourd'hui d'évaluer sa distribution originale. Dans cette étude, nous avons étudié les collections de 61 musées régionaux et universités en France. Cinquante avaient des spécimens de *Pseudunio auricularius*, dont 358 ont pu être localisés au moins à une portion de rivière ou aux environs d'une ville. Cinq localités étaient auparavant inconnues et la quantité de données collectées par rivière ou par drainage était très différente de celle connue par la littérature. À la suite de cette étude, des enquêtes approfondies ont été réalisées avec une équipe de plongeurs. Cela a permis de découvrir des coquilles et une population manquée dans un drainage qui avait été étudié de manière approfondie quelques années auparavant.

Introduction

When thinking about museum collections, one generally thinks of national museum collections (e.g. Araujo & Ramos, 2001). Indeed, for France, the massive Lamarck, Férussac, Germain and Locard collections are stored in the National Museum of Natural History in Paris.

Other relevant collections are stored in foreign national museums: Bourguignat and Délessert collections are in Geneva (Switzerland), Daparnaud collection is in Vienna (Austria).

However, regional museum collections are widespread in France, handled by curators and assistant curators, and together constitute a

1. The data of this paper used here has already been published in Prié *et al.* (2018). However the results of museum investigation were presented in a few lines in this paper, which aimed mostly at summarising available data on *P. auricularius* in Europe. Here, we present the museum data much more in detail (four data have been added) and emphasize on the value of regional museum collections. We want here to highlight not the results for themselves (distribution of *P. auricularius*) but the value of regional collections for scientists.

significant amount of material. Many important collections are stored in regional museums or universities: amongst others, the collections of: Normand (Museum of Lille), Hermann (Museum of Strasbourg), Lecoq (Museum of Clermont), Drouët (Museum and University of Dijon), Michaud, Terver and Coutagne (Museum of Lyon), Deshayes (University of Lyon), Dumont & Mortillet (Museum of Annecy), Gassies (Museum of Bordeaux), Moquin-Tandon and Rambur (Museum of Toulouse), Paladilhe (University of Montpellier), Chatenier and Gras (Museum of Grenoble), Couturier, Hagenmüller and Pallary (Museum of Marseilles), Caziot and Verany (Museum of Nice).

In this study, we revisited the actual knowledge about the historical distribution of the endangered Giant Freshwater Pearl Mussel *Pseudunio auricularius* (Spengler, 1793) (= *Margaritifera auricularia*) (Fig. 1) in the light of museum collections data. *Pseudunio auricularius* was known from the literature to be widespread in Western Europe until the end of the 19th century. Since then, it has declined to a point that

it was believed to be extinct when the European Habitat Directive species lists were established. Recently, a few populations have been re-discovered in France and Spain and the species is now listed in Annex II of the Habitat Directive, protected in France and Spain and considered Critically endangered (CR A2ac, Prié, 2010) by the IUCN. Subsequently, conservation programs have been set up aiming at artificial reproduction in order to re-introduce the species in the wild and trying to find remaining populations (Prié *et al.*, 2018). For both purposes, we need a precise picture of the original distribution of *P. auricularius*, for a better understanding of its ecological requirement, to propose reintroduction sites and to know where to search for potentially remaining populations. Literature provides data on the original distribution of the species but is often too vague and remains deficient. In 2015, an extensive survey of regional museum collection has been set up to supplement the literature review of the species. This note presents the results of this survey¹.



Fig 1. *Pseudunio auricularius* (Spengler, 1793), in the Lot river, Villeneuve, Lot-et-Garonne, Gassies leg. (Drouët's collection)
Muséum-Jardin des Sciences de Dijon

Material and methods

We investigated and listed all the regional collections held in universities or museums in France (cf. Bertrand, 2001). Museums and some universities were contacted and information such as existing databases and pictures of shells and vouchers was collected. The most relevant collections were visited. When a database was available, special attention has been taken to the numerous synonyms of the species.

A final database of the specimens of *P. auricularius* including specimen locality, date and collector (when available) could be established. Some specimens were collected in recent times (i.e. after 2000): 68 in Paris (leg. V. Prié 2007), 18 in Bordeaux (leg. Office national de l'eau et des milieux aquatiques) and one in Bourges (leg. Office national de l'eau et des milieux aquatiques). These specimens were not taken into account in this paper.

Results – discussion

Available collections data

A total of 61 regional collections hosted by museums or universities were found. Of the 61 regional museums contacted in France, 11 could not be contacted for some reason or did not answer our request. Of the 50 remaining, 4 did not have any malacological collection. Out of these, 28 had at least one specimen of *P. auricularius* in their collections. The biggest collections of *P. auricularius* are present in Lyon, Paris, Toulouse, and Bordeaux (Fig. 2). A total

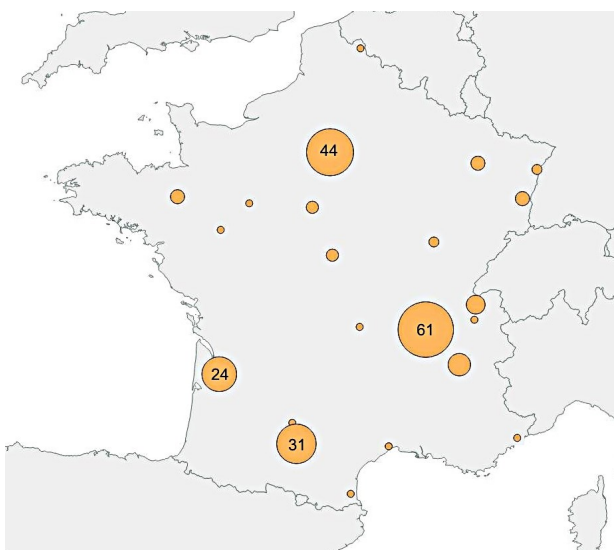


Fig 2. Localization of Museums holding at least one specimen of *P. auricularius*. Dots are size in proportion to the number of specimens. Main collections in France are held in Lyon, Paris, Toulouse and Bordeaux



Fig 3. Collection places of specimens identified from Museum collections (dots, precise location; lines, rivers only)

of 392 specimens were identified in regional museum collections. Among them, 216 could be localised at least at the river scale (Fig. 3) and a collection date could be estimated for 159 of them.

In their survey of national museums, Araujo and Ramos (2002) enquired 36 state museums. Six of them had shells collected in France (Academy of Natural Sciences of Philadelphia, Institut royal des Sciences naturelles de Belgique, Muséum d'histoire naturelle de Genève, Ohio State University Museum, United States National Museum, Instituut voor Systematiek en Populatiebiologie) representing 60 specimens collected in 13 French rivers (Adour, Aisne, Arros, Charente, Dordogne, Dronne, Garonne, Lot, Saône, Seine, Somme, Vesle, Yonne). Here, we show that regional collections not only add much more specimens (206), but also more localities (22 rivers: Adour, Aisne, Arrats, Arros, Aube, Charente, Chers, Dordogne, Dronne, Escout, Garonne, Isle, Loire, Lot, Rhin, Saône, Save, Seine, Tarn, Vesle, Vézère, Yonne).

Shells origins

Most of the specimens were collected in the Garonne drainage (Fig. 4). Amongst these, about a third were collected in one of the Garonne's main tributary, the Dordogne drainage. Although living populations remain in the Garonne drainage, in the Dronne and the

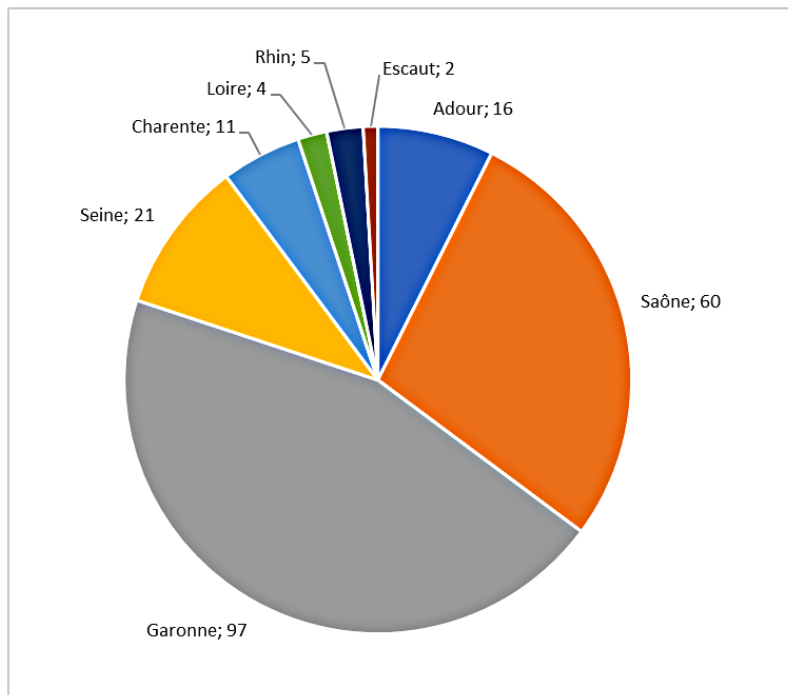


Fig 4. Origin and number of specimens identified in French Museum collections

Save Rivers (Prié *et al.*, 2018), such a proportion was unexpected. More surprisingly, another third came from the Garonne mainstream, between the towns of Agen and La Réole. La Réole is the place where the seas' influence in the Garonne estuary ends (salinity occurs at least occasionally downstream La Réole). No

populations nor shells are known nowadays from the Garonne mainstream.

Over a quarter of the shells identified in museum collections came from the Saône drainage. Noticeably, 39 of the 60 shells came from the Coutagne collection and were collected in a single place: a gravel mound left on the banks of the Saône after the river had been dredged.

Twenty-one shells came from the Seine drainage, where the species is supposed to have recently disappeared (Prié *et al.*, 2008; Prié *et al.*, 2018). Shells can still be found nowadays in tributaries to the Seine such as the Oise and Aisne Rivers. Fifteen shells came from the Adour drainage, where a few hundreds of specimens are still living. But half of them came from the Arros tributary, a river that had been overlooked by previous field surveys (Fig. 5).

Only eleven shells came from the Charente River. This low number of shells was unexpected as the Charente River hosts the biggest population of Giant Freshwater Pearl Mussels in the world (Prié *et al.*, 2018), and this population was known from a long time as industries were set up to make mother-of-pearl buttons out of the shells (Bonnemère, 1901 ; Faideau, 1938).



Fig 5. *Pseudunio auricularius* (Spengler, 1793), in the Arros river, Gers, Dupuy abbot leg. (Drouët's collection) - Muséum-Jardin des Sciences de Dijon

Collection dates

A collection date could be estimated for 159 specimens (Table 1). If we exclude from the dataset the particular case of the Coutagne’s collection in 1879, with 39 shells collected at one time on the bank of the Saône River after dredging, we observe that the rate of shell collection is more or less regular, between 8 to 15 per decade (Fig. 6). By the early XXth century, this collection rate begins to decline, ending with no shells collected at all at the end of the XXth century. This plunge is correlated with what is assumed about the species decline. Ancient literature considers the species as widespread in Western Europe up to the 1900s, while it was even not considered in the lists of threatened species in 1979 when the Habitat Directive was implemented, because scientists thought it was already extinct. However, this approach is biased by (i) the rarity of the collections in the first third of the XIXth century, and (ii) the global decline of collections after 1920. Noticeably, most shells were collected

during the XIXth and early XXth centuries in “big collections”, but most malacologists collections do not contain any *P. auricularius* shells, or only a few (e.g. Drouët’s collection, with many unionids but very few *P. auricularius*).

Conclusion

The Giant Freshwater Pearl Mussel remains an extremely rare and endangered species. The rarity of shells in collections reflects not only a rarity in nature, but also the fact that it is was difficult to collect: the Giant Freshwater Pearl Mussel lives in the bottom of large rivers, downstream, with generally turbid waters (see Prié *et al.*, 2018) and is thus much harder to collect than its related species the Freshwater Pearl Mussel *Margaritifera margaritifera*, which in France generally lives in shallow, clear and pristine rivers of the upstream ecosystems.

However, although scarce, the data collected in this study allowed discovering previously unnoticed data. In particular, we remarked on

Dates	Number of specimens	Dates	Number of specimens
1820-1839	18	1920-1939	11
1840-1859	18	1940-1959	1
1860-1879	66	1960-1979	2
1880-1899	28	1980-1999	0
1900-1919	15		

Table 1. Number of specimens deposited in museum collections per 20 years

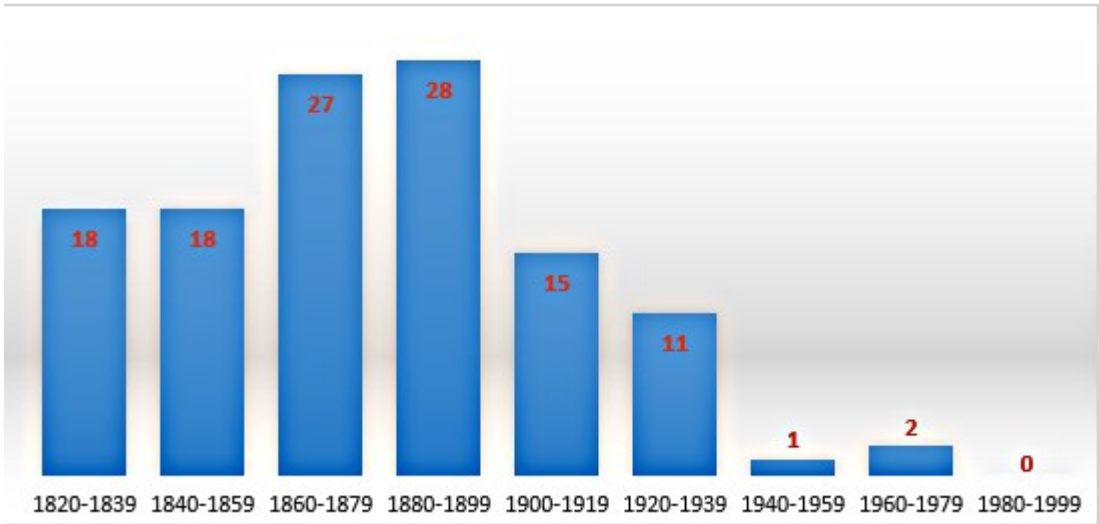


Fig 6. Number of specimens per collection dates intervals. This figure does not include the particular case of Coutagne’s collection in 1879.

the shells from the Arros River, found in very low number but in many collections. The Arros River had been completely overlooked by the last decade program of field surveys aimed at rediscovering the species in France. This observation lead to a field survey, in 2016, in this river and a living population could be rediscovered there, numbering about 200 specimens (Prié *et al.*, 2018). Museum collections are not only valuable for reconstructing the past, they can also enlighten the present situation.

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