# DISTRIBUTION OF INDIGENOUS AND NON-INDIGENOUS CRAYFISH POPULATIONS IN THE POITOU-CHARENTES REGION (FRANCE): EVOLUTION OVER THE PAST 25 YEARS

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## ABSTRACT

Subsequent surveys carried out from 1978 to 2003 demonstrated a high disappearance of *Austropotamobius pallipes* populations from the region and the alarming spread of non-indigenous species like *Procambarus clarkii* and *Pacifastacus leniusculus*. Represented by 137 populations in 1978, *A. pallipes* is now almost completely restricted to only one department, with 45 populations recorded, representing a decrease of 68% of the population number in 25 years, with a loss of 40% of populations in the last 6 years. Most of the disappearances of crayfish are unexplained. For the 22 others, the main reasons of the disappearance of indigenous crayfish populations were due to (1) habitat destruction by channelisation, (2) decrease of water quality by use of agricultural chemicals, (3) the construction of ponds or lakes changing the physical and chemical parameters of brooks inhabited by indigenous crayfish, (4) the introduction of non-indigenous species, mainly *P. leniusculus* and recently (5) crayfish plague implicated and characterized in the disappearance of two populations, two additional ones being suspected.

Introduced in 1978 in Vienne department, *P. leniusculus* has now been found in 28 locations. First record of *P. clarkii* was in 1988 in Charente-Maritime department; since it has spread in most of the hydrographic basin of this department.

**Key-words:** *Austropotamobius pallipes*, Non-indigenous crayfish, Distribution, Poitou-Charentes, France.

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# RÉPARTITION DES POPULATIONS D'ÉCREVISSES INDIGÈNES ET NON INDIGÈNES DANS LA RÉGION POITOU-CHARENTES (FRANCE) : ÉVOLUTION SUR 25 ANS

## RÉSUMÉ

D'importants suivis de population d'écrevisses effectués entre 1978 et 2003 ont montré une forte disparition des populations d'*A. pallipes* et une propagation alarmante des espèces non indigènes comme *P. clarkii* et *P. leniusculus*. Représentées en 1978 par 137 populations, le nombre est à présent de 45 populations, représentant une diminution de 68 % en 25 ans, avec une perte de 40 % des populations ces cinq dernières années. La plupart des disparitions de populations sont inexpliquées. Pour les disparitions dont les causes peuvent être présumées ou observées, on trouve par ordre décroissant d'importance : (1) la destruction de l'habitat (recalibrage), (2) la diminution de la qualité de l'eau par utilisation de produits chimiques pour l'agriculture, (3) la construction de mares ou d'étangs qui changent les paramètres physico-chimiques des cours d'eau (4) l'introduction d'écrevisses non indigènes, principalement *P. leniusculus* et récemment (5) la peste de l'écrevisse qui a été caractérisée dans la disparition de 2 populations, et suspectée dans 2 autres cas.

Introduite en 1978 dans le département de la Vienne, *P. leniusculus* est présente dans 28 sites (de ce département). Les premières observations de *P. clarkii* datent de 1988 en Charente-Maritime, depuis elle s'est étendue à la plupart des bassins hydrographiques de ce département.

**Mots-clés :** *Austropotamobius pallipes*, écrevisses non indigènes, répartition, Poitou-Charentes, France.

## INTRODUCTION

The white-clawed crayfish, *Austropotamobius pallipes* (Lereboullet) is an indigenous crayfish species found in Western Europe (geographic distribution reviewed in HOLDICH, 2002). Its distribution is now greatly reduced throughout its natural range due to several causes: (i) the pollution of freshwaters by domestic, agricultural, or industrial wastes, which can be totally toxic and responsible for major declines in the populations, (ii) habitat loss with engineering works, which can completely destroy the habitat of freshwater species; (iii) overfishing/overexploitation; (iv) introduction of alien species highly tolerant to the crayfish plague and acting as vectors of this disease; this fungus has killed off most populations of the white-clawed crayfish in Spain following the introduction of *Procambarus clarkii* (ALONSO *et al*., 2000).

As a result of this decline, this species is included in Appendix III of the Bern Convention as protected species and in the Red Data List of endangered species by the International Union for the Conservation of Nature and Natural Resources (GROOMBRIDGE, 1993). In response to the Convention on Biological Diversity signed at the Earth Summit in Rio de Janeiro in 1992, the species was also included in Annex II and V of the Habitat Directive 92/43/CEE of the European Community. This species is also regarded as a heritage species (FÜREDER and REYNOLDS, 2003). Furthermore, in habitats where it occurs, *A. pallipes* is considered as a keystone species (MATTHEWS *et al*., 1993; NYSTRÖM, 2002).

In France, the species occupies mainly streams. It prefers calcium-rich rivers and streams with a good water quality and not too much sediment. Shelter such as that provided by rocks/stones, water plants and tree roots, or a bank into which it can burrow, are important for its survival. It is now mostly found in the headwaters of rivers, in isolated populations.

Three non-indigenous species originating from the North American continent were represented in the French hydrographic system. Amongst them, *Orconectes limosus* is the most widely spread. Since its introduction between 1911-1913 with 2000 individuals, it has occurred in all French drainages mainly within large rivers, from second order (small rivers) and up (VIGNEUX, 1997; ARRIGNON *et al*., 1999). The signal crayfish (*Pacifastacus leniusculus*) occurred in 1995 in 47 departments since its introduction from Sweden in 1972 and from the USA in 1974 (LAURENT, 1997). This species is a direct competitor of the indigenous *A. pallipes* because it shares the same habitat in headwaters of rivers. The Louisiana crayfish (*Procambarus clarkii*) was introduced in 1974 into Western France and by 1995 it had reached 36 departments, particularly marshy and rice area in Brittany and the Camargue (ROSECCHI *et al*., 1997).

The present paper describes the evolution of indigenous and alien populations of crayfish within a French region since 1977 from historical data of national fisheries French council and field operations performed in summer 2003. When a population of *A. pallipes* could not be found again, the causes for this disappearance were investigated. These causes were extremely poorly known in the literature. This detailed mapping is a prerequisite for a conservation plan.

## METHOD

The region of *Poitou-Charentes* covers 25 810 km$^2$ in Western France and possesses mostly calcareous soils offering a favourable hydro-chemical profile for crayfish. It has four Départements: *Vienne, Deux-Sèvres, Charente* and *Charente-Maritime* (Figure 1).

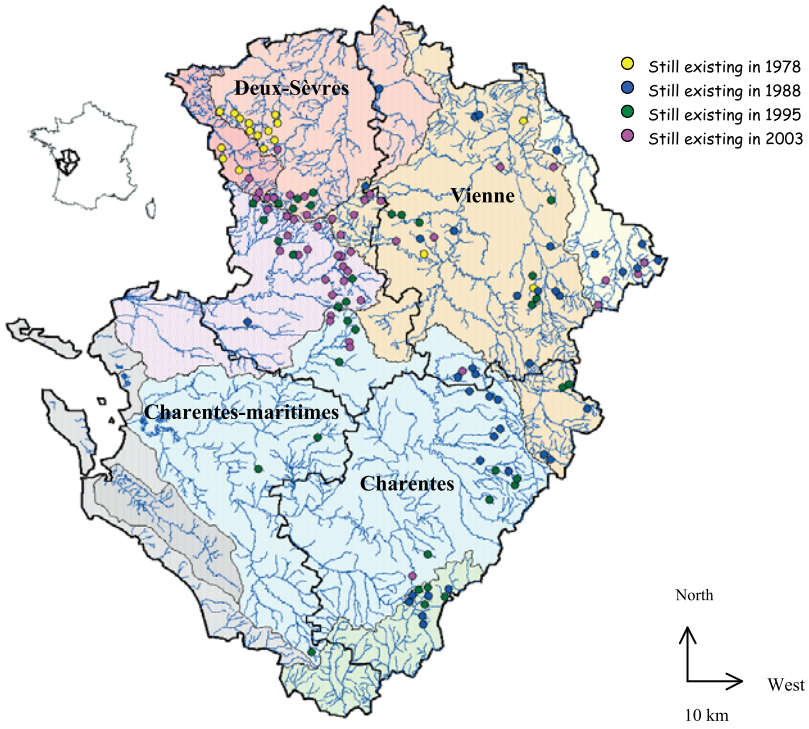


**Figure 1**
**Distribution of *A. pallipes* populations since 1978 with hydrographic network (blue lines) and departement limits (black lines).**

**Figure 1**
**Distribution des populations d'*A. pallipes* depuis 1978 avec le réseau hydrographique (lignes bleues) et les limites départementales (lignes noires).**

This paper presents data collected both by the *Brigades Départementales of Conseil Supérieur de la Pêche* (CSP) from four major crayfish surveys carried out in 1978, 1988, 1995 and 2002 (VIGNEUX *et al*., 1993; CHANGEUX, 1996; VIGNEUX, 1997; CHANGEUX, 2003) and by complementary surveys (on 20 sites), done in 2003, mainly in the *Vienne* and *Deux-Sèvres* departments. Crayfish were sampled using baited traps in deep waters or captured by hand where the water level was shallow enough. In 2003, 10 traps spaced at 10 m intervals were used. The traps are long and conical; the greatest diameter is 240 mm and the smallest 150 mm. The traps are injection moulded in blue polyethylene plastic with mesh size of 14 mm. Traps baited and set in the afternoon were retrieved the following morning after 12 hours.

These surveys only recorded presence or absence of crayfish at sites where *A. pallipes* was expected to occur. To confirm the disappearance of an *A. pallipes* population, field operation with lights by night was also performed. When a population of *A. pallipes* could not be found again, the causes for this disappearance were investigated.

## RESULTS

### A. pallipes

Crayfish used to be widely distributed in the *Deux-Sèvres* and were well represented throughout the *Vienne* and *Charente* départements (Figure 1). In 2003, they were mostly found in the *Deux-Sèvres* département, with only a few isolated populations in the other parts of the *Poitou-charentes* region. In 1978, 137 populations of *A. pallipes* were recorded in the region. In 1988, 120 populations were found and by 1995 only 81 populations existed in the region, a loss of more than 30% of crayfish populations in just 7 years. In 2003, only 45 populations were recorded, representing only 32% of the 1978 number.

Most of the disappearances of crayfish are unexplained. The main known causes for the loss of crayfish populations in the region are the crayfish plague (*Aphanomyces astaci*), the introduction of non-indigenous species, habitat degradation and pollution (Table I). Pesticides were implicated in the loss of few populations, including one in the *Crochet* stream (Vienne), where the chemicals lambda cyanalochtrine and isoproturon were identified. Organic pollution (farm waste) was also found to be the cause for the loss of at least two populations. At least, two populations in the *Deux-Sèvres* department disappeared following the creation or the maintenance of a pond. The occurrence of crayfish plague, *A. astaci*, was confirmed in the *St-Christophe* river from *Deux-Sèvres* (NEVEU and BACHELIER, 2002) and suspected in 3 other rivers in 2001. Drought can also cause the loss of a population. During summer 2003, an unprecedented heat wave hit France and two crayfish sites in the *Vonne* catchment (*Poitou-Charentes*) completely dried out.

**Table I**
**Known causes for disappearance of *A. pallipes*.**

**Tableau I**
**Causes connues de la disparition d'*A. pallipes*.**

| Cause | Number of populations affected |
|---|---|
| Pollution (organic) | 4 |
| Pollution (toxic) | 8 |
| Creation or maintenance of a pond | 4 |
| Aphanomycoses | 4 |
| Drought | 2 |
| Exotic crayfish | 4 |

**Non-indigenous crayfish**

The introduction of non-indigenous crayfish, mainly *P. leniusculus*, is also implicated in the loss of indigenous populations. *Orconectes limosus* has been widely distributed in the main rivers of the region for almost a century (ARRIGNON, 1997), but *P. clarkii* and *P. leniusculus* are relative newcomers, being first sighted in the surveys of 1988 and 1978 respectively. These two species have spread considerably in diffusive way since their introduction, *P. clarkii* in the *Charente-Maritime* department and *P. leniusculus* in the Vienne department (Figure 2). There are now 28 populations of *P. leniusculus* recorded in the *Vienne* department. They are situated in the headwaters of rivers and result from both human translocations and natural colonisation. One example of cohabitation between *O. limosus* (dam brook) and *A. pallipes* occurs in the *Rourie* brook.

One population of *Astacus leptodactylus* has been recorded in *Auxances* brook (*Deux-Sèvres* department).

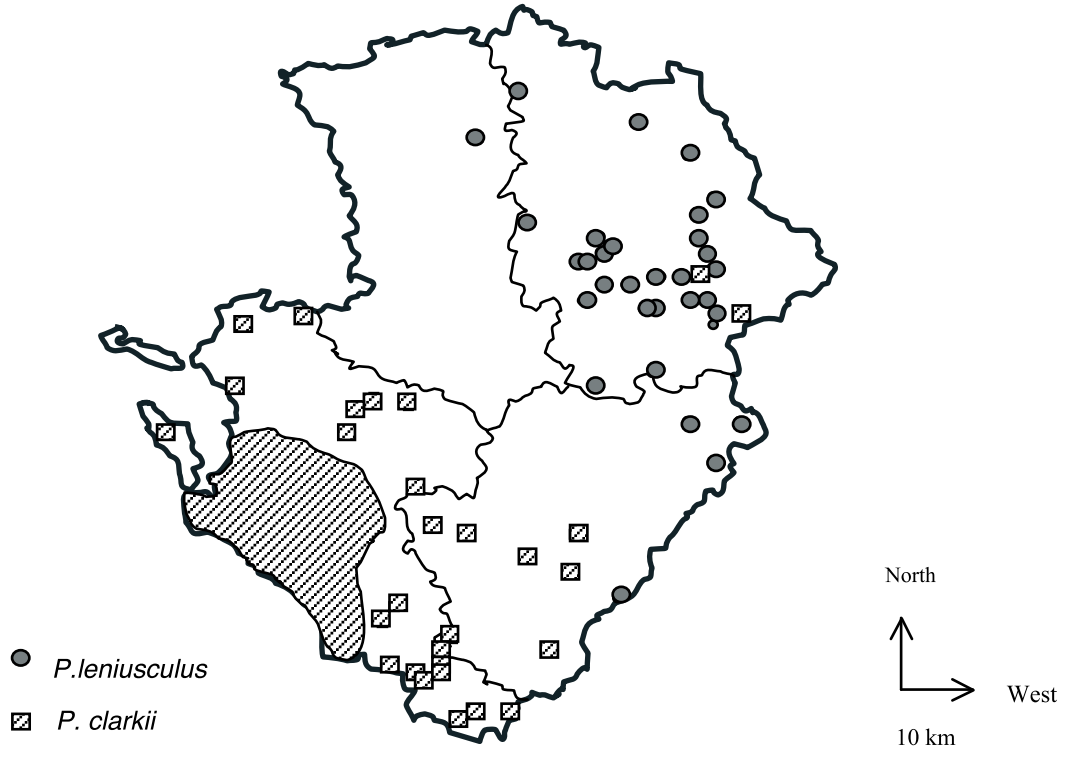


**Figure 2**

**Distribution of *P. clarkii* (hatched squares) and *P. leniusculus* (grey circles) in *Poitou-Charentes* region. The shaded area represents a zone where *P. clarkii* is widely distributed. First records for *P. clarkii* in 1988 and for *P. leniusculus* in 1978 in *Vienne*.**

**Figure 2**

**Distribution de *P. clarkii* et *P. leniusculus* dans la région *Poitou-Charentes*. Les aires hachurées représentent une zone colonisée par *P. clarkii*. Premiers signalements de *P. clarkii* en 1988 dans la zone hachurée et de *P. leniusculus* en 1978 en *Vienne*.**

## DISCUSSION

The surveys carried out over the past 25 years demonstrate the loss of many indigenous crayfish populations in the *Poitou-Charentes* region. Only about a third of the populations remain today in this part of France. This situation is unfortunately similar to that in other regions of France (for example, the department of *Creuse*) and elsewhere in Europe (GHERARDI and HOLDICH, 1999; CHANGEUX and LAURENT, 2003; CHANGEUX, 2003). The many causes of this decline include the crayfish plague, pollution, habitat alterations and the introduction of non-indigenous species.

Crayfish plague was first reported in Europe in the 19th century with massive mortalities observed in Italy, France and Germany (reviewed in ALDERMAN, 1996). This disease has affected indigenous crayfish stocks throughout the European continent, most recently in Britain (ALDERMAN *et al*., 1984), Ireland (REYNOLDS, 1988) and Spain (ALONSO *et al*., 2000). Although widespread mortalities in France caused by *A. astaci* mostly occurred from 1876 to 1884 (ALDERMAN, 1996), this disease still constitute today a threat to the conservation of *A. pallipes*. Several plague events have been recorded in recent times, in various regions (MACHINO and DIEGUEZ-URIBEONDO, 1998; COLLAS and SALEK, 2002). In England, after a lull of several years, one case of plague was reported in Cambridgeshire in 1999 (SLATER *et al*., 2000; HOLDICH, 2003). As long as resident populations of American crayfish, which are tolerant vectors of the fungus, exist In France, the threat of contamination to indigenous crayfish remains important. The spores of *A. astaci* can be transported from one river to another through fish introductions or possibly through fishing gears (REYNOLDS, 1988; OIDTMANN *et al*., 2002).

Pollution, particularly from pesticides, was implicated in the loss of several populations in *Poitou-Charentes*. Pollution events might be the cause of many population losses in Europe, but this is often difficult to ascertain. Indeed, contamination by pesticides is often brief and the presence of molecules can break down quickly. Is it therefore difficult to confirm that pesticides are responsible for the disappearance of a crayfish population. Contamination by sheep dip was believed to have a cause on the decline of *A. pallipes* in Wales (HOWELLS and SLATER, 2003). Synthetic pyrethroids (such as lambda cyanlochtrine, identified in *Poitou-Charentes*), used for sheep dipping, are particularly toxic to invertebrates and thus, freshwater crayfish (HOWELLS and SLATER, 2003).

Habitat degradation due to drought or anthropogenic modifications is also cited as a cause of the decline of *A. pallipes* in Europe. Human disturbances that affect crayfish include canalisation, dredging, construction of reservoirs and engineering works (MCCARTHY, 1977; GHERARDI *et al*., 1999; GUTIÉRREZ-YURRITA *et al*., 1999). Crayfish populations in France are susceptible to drought because they inhabit headwater sites, where the river is narrow and shallow. Drought has also been found to be problematic in Portugal and Italy (MORI *et al*., 1996; GHERARDI *et al*., 1999; GUTIÉRREZ-YURRITA *et al*., 1999). Artificial private ponds, constructed for fishing or as water reserves, are of common occurrence in the *Poitou-Charentes* region. The creation of a pond can be detrimental to a downstream crayfish population because of the resulting modifications in flow, dissolved oxygen, temperature or sedimentation. These ponds are sometimes emptied into the river, which loads the water flow with sediments, organic matter and result in poorly oxygenated water.

Non-indigenous crayfish species were introduced for their fisheries and aquaculture potentiel. *Pacifastacus leniusculus* was stocked in European rivers as a replacement for the indigenous populations devastated by plague. It was first sighted in Poitou-Charentes in 1978. The signal crayfish comes into direct competition with *A. pallipes* because it prefers first order streams in the headwaters of catchments, and occupies similar habitats (HILEY, 2003; CHANGEUX, 2003). *Pacifastacus leniusculus* is a vector of the crayfish plague, but even when plague-free populations of signal crayfish coexist with *A. pallipes*, the former will eventually outcompete the later (HOLDICH and DOMANIEWSKI, 1995;

HOLDICH *et al*., 1995). *Procambarus clarkii* tends not to inhabit the same habitat as *A. pallipes*, preferring the marshes of *Charente-Maritime*. In Spain and Italy, this invasive species can be found in high densities in rice fields, marshes and ponds (GHERARDI *et al*., 1999; GUTIÉRREZ-YURRITA *et al*., 1999).

Finally, the sunfish, *Lepomis gibbosus* are responsible to extinction of white-clawed crayfish in one of the seven ponds in the natural reserve of *Pinail* (*Vienne* department).

## CONCLUSIONS

The indigenous crayfish *A. pallipes* is now restricted mostly to two departments in the region (*Deux-Sèvres* and *Vienne*). In 2004, no population of *A. pallipes* has been found in two other departments (*Charente* and *Charente-Maritime*) (Bramard, Pers. Com.).

Non-indigenous crayfish species on the other hand are expanding their distribution and increasing in numbers. The surveys carried out over the past 25 years underline the need for strict conservation measures to preserve the remaining white-clawed crayfish populations in the *Poitou-Charen*tes region. Despite national legislation, which prevents the importation of non-indigenous living crayfish from foreign countries and transport of live animals through the country, the spreading of non-indigenous species is impressive and very worrying for the future of *A. pallipes* in our region. Methods to eradicate localized populations should be attempted (review by SOUTY-GROSSET *et al.,* 2004). For the others that cannot be eradicated, measures allowing controlling the spread of non-indigenous crayfishes should be taken.

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