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KALATUTKIMUKSIA - FISKUNDERSÖKNINGAR

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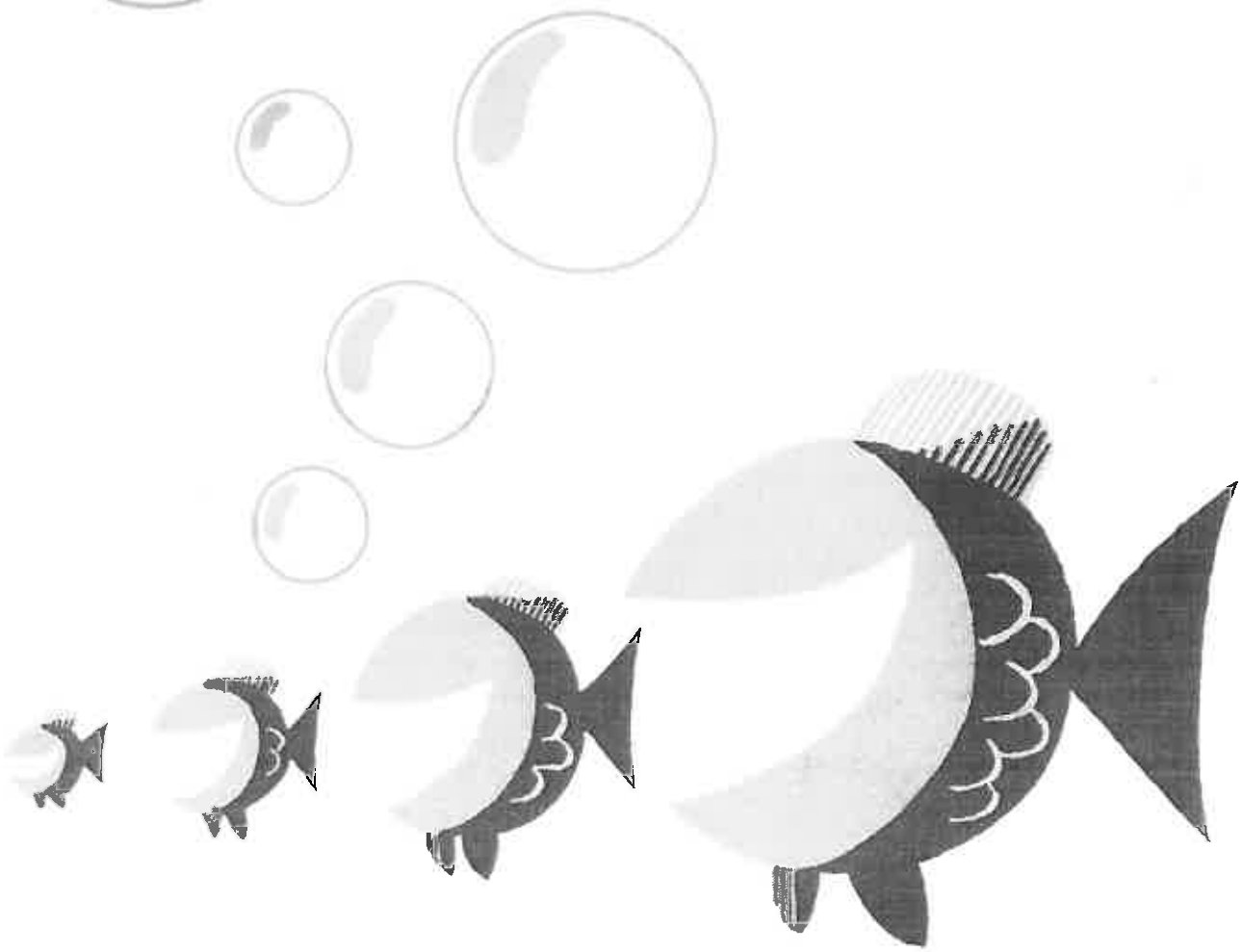

RIISTA-JA KALATALOUDEN TUTKIMUSLAITOS
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KALATUTKIMUKSIA – FISKUNDERSÖKNINGAR

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Status of crayfish stocks, fisheries, diseases and culture in Europe

Report of the FAO European Inland Fisheries Advisory Commission (EIFAC) Working Party on Crayfish

Edited by

Kai Westman, Markku Pursiainen and Pia Westman

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ACTIVITIES OF THE EIFAC WORKING PARTY ON CRAYFISH

KAI WESTMAN[1]

Crayfish have attracted considerable gastronomic attention in Europe for centuries. The crayfish plague, in particular has reduced the natural stocks of crayfish ever since 1860; because there were no effective methods to control the disease, interest in crayfish fisheries and in management of crayfish stocks fell sharply during the first decades of the 1900s.

Interest in developing freshwater crayfish fisheries has, however, revived strongly in Europe since the 1970s. This is the result not only of the growing demand for crayfish for consumption but also of the availability of plague-resistant North-American species, especially the signal crayfish, **Pacifastacus leniusculus**, and the red swamp crayfish, **Procambarus clarkii**, for stocking purpose. Interest in the management and utilization of the native European species has also grown rapidly. The rising demand for crayfish as a delicacy has consequently caused both the market price of crayfish and the interest in crayfish culture to rise.

According to a rough estimate, some 8 000 - 8 500 tonnes of freshwater crayfish are produced annually in Europe, although the important Turkish production of over 6 000 tonnes recently collapsed due to the plague.

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The drop in natural stocks of crayfish has led to increasing quantities of crayfish being imported for consumption in the EIFAC region. The demand for freshwater crayfish in Europe has already reached some 9 000 - 10 000 tonnes annually.

It should also be remembered that the crayfish plays an important role in the aquatic ecosystem, especially by grazing the vegetation. This is of practical importance, as crayfish can be used to reduce the vegetation growing in eutrophicated lakes, ponds, canals and rivers.

In view of the expanding interest in crayfish in Europe, the Tenth Session of EIFAC, held in Hamburg, Federal Republic of Germany, in 1978, recommended that a working party on crayfish should be established. The objectives of the Working Party are to stimulate and coordinate studies and activities leading to the effective management of crayfish stocks and to the development of crayfish culture.

At the Fourth International Symposium on Freshwater Crayfish, held in Thonon-les- Bains, France, in 1978, development of co-operation between the International Association of Astacology (IAA) and the EIFAC Working Party on Crayfish was recognized to be of primary importance. It was agreed that duplication of work would be avoided by exchanging information on proposed activities, programmes, preparation of reports, etc.

Collection of information on crayfish stocks, fisheries, catches and research in Europe was identified as a priority area for action by the Working Party at its first meeting, held during the 11th Session of EIFAC in Stavanger, Norway in 1980 (Westman 1980).

In the beginning of the 1980s, the Working Party collected information on the status of crayfish stocks, fisheries, diseases and culture in Europe, and identified the main problems in developing crayfish fisheries (Westman and Pursiainen 1982a). Information on institutes, researchers and programmes related to research on crayfish in Europe was also collected (Westman and Pursiainen 1982b). Both reports were presented at the 12th Session of EIFAC, held in Budapest, Hungary, in 1982.

The Working Party to date has had nine meetings (Stavanger, Norway, 1980; Davis, California, USA, 1981; Budapest, Hungary, 1982;

Rome, Italy, 1984; Aarhus, Denmark, 1984; Lund, Sweden, 1984; Bordeaux, France, 1986; Lausanne, Switzerland, 1987; and Gothenburg, Sweden, 1988). The meetings have been held in conjunction with Sessions of EIFAC or the Symposia of the IAA. The reports of the activities of the Working Party have been presented at the EIFAC Sessions, and they are included in the Session reports. The last report is from 1988 (FAO 1988).

Owing to the ever-increasing interest in and importance of crayfish culture, for both stocking and consumption, it was decided at the 14th Session of EIFAC, held in Bordeaux, France, in 1986, that a workshop on crayfish culture should be arranged during the next intersessional period. Norway kindly offered to host the meeting. The Workshop, which was first of its kind, was held in Trondheim, Norway on 16-19 November, 1987, in cooperation with the Norwegian Directorate for Nature Management. The aim of the Workshop was to review the current knowledge, define the gaps in our knowledge that prevent further development and to recommend methods and research promoting crayfish culture. A report about the Workshop was published in 1989 (Skurdal, Westman and Bergan 1989).

At the 14th Session of EIFAC, it was also decided to update the status report of crayfish stocks and fisheries in Europe (Westman and Pursiainen 1982a). To fulfil this task, in 1987 the Convener asked the members of the Working Party and EIFAC`s correspondents to update the information concerning the respective country and, especially to report on species occurring in Europe, the state of their populations, trapping and catches, and to provide information relating to culture.

The present report contains information from 24 European countries. The information submitted for the report has been very heterogenous. In order to improve the usability of the report, the responses have been made as uniform as possible. The information is presented country by country. On the basis of the responses a summary report on the status of crayfish stocks, fisheries, diseases and culture has been prepared.

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THE SITUATION OF CRAYFISH STOCKS, FISHERIES, DISEASES AND CRAYFISH CULTURE IN EUROPE - A REVIEW

Kai Westman[1], Markku Pursiainen[2] and Pia Westman[1]

1. Introduction

Ever since 1860, the disastrous crayfish plague fungus **Aphanomyces astaci** has been inflicting great losses on populations of the native crayfish species occurring in Europe. Numerous unsuccessful attempts have been made to control the plague, but no resistant strains of the indigenous species have developed and European crayfish appear incapable of re-establishing themselves in chronically infected watercourses.

In the past few decades, technological and economic development has brought marked changes in the condition of inland waters in Europe, thereby increasing the damage to crayfish stocks and fisheries.

However, interest in developing freshwater crayfish fisheries has been on the increase again since the beginning of the seventies, thanks to the availability of promising plague-resistant North American species, especially the signal crayfish **Pacifastacus leniusculus** and the red swamp crayfish **Procambarus clarkii**.

With the aim of redressing the damage already suffered, a growing amount of attention has in recent years been devoted to managing crayfish stocks. In particular, there has been rapid growth in cultivation of young crayfish of both native and introduced species for stocking purposes in many European countries. With populations dwindling, catches have been inadequate to satisfy demand; consequently, interest in culturing crayfish for consumption is also growing fast.

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According to a rough estimate, some 8 000-8 500 tonnes of freshwater crayfish are produced annually in Europe, with consumption in the region of 9 000 - 10 000 tonnes. Before the outbreak of the crayfish plague in Turkey in the mid-1980's, that country produced and exported to Western Europe over 6 000 tonnes crayfish a year. In recent years, imports, especially from North America, have been increasing to satisfy the constantly incrasing demand for freshwater crayfish.

This article is based mainly on the information obtained from enquiries sent to the members of the EIFAC Working Party on Crayfish and the EIFAC's correspondents. This is due to the fact that with the exception of a few European countries, official statistical data or other public material dealing with crayfish trapping, catches and culture do not appear to exist. Some information has already presented elsewhere (Westman et. al. 1989).

2. Freshwater crayfish species in European countries

According to Albrecht (1982), there are five native freshwater crayfish species in Europe: **Astacus astacus, A. leptodactylus, A. pallipes, A. pachypus** and **A. torretium**. To restore production in waters devastated by the crayfish plague fungus, a total of four exotic, plague-resistant, self-reproducing species have been introduced into European inland waters from North America: **Orconectes limosus, Pacifastacus leniusculus, Procambarus clarkii** and P. acutus (e.g. Westman, 1982).

Data on the current incidence of various crayfish species in Europe and their origin are compiled in Table 1. The data were received through the enquiries mentioned earlier and the species names are those used by respondents. The distribution of both native and introduced crayfish species in Europe are presented in Figs. 1-3.

At least one native species of crayfish occurs in most European countries. One country (Hungary) has three and a couple (Austria, Yugoslavia) as many as four European species. Israel is the only country covered by our enquiries that appears to have no freshwater crayfish.

In most of the European countries from which information has been

received, there is nowadays at least one species introduced from North America; several have two.

P. leniusculus (the signal crayfish) was first introduced to Sweden 30 years ago and has already been planted in more than 1 000 lakes and rivers. In Finland, it can look back on a 20-year history and nearly 100, mainly small, lakes have been stocked with the species. In Britain, where it was first introduced in 1976, some 250 lakes and ponds have been stocked. In many other European countries, too, this species has now been around for 15-10 years.

The native range of P. leniusculus is the West Coast of North America. This species, which closely resembles the noble crayfish, A. astacus, is nowadays found in at least 12 countries.

The red swamp crayfish, P. clarkii, which originates from the floodplains of many rivers in the southern USA, has been transplanted to five southern European countries. The native range of O. limosus is the East Coast from Maine to Virginia. This species, which was introduced into Europe as early as 1890, occurs in at least 8 countries, especially in Central Europe. P. acutus has been introduced only to Spain.

Crayfish have been brought to Europe as adults taken from wild populations in North America, hatchlings have been produced in Europe, or the crustaceans have themselves spread from country to country (especially O. limosus). Besides those brought directly from across the Atlantic, North American crayfish species have also been introduced, either accidentally or intentionally, from at least Africa (P. clarkii from Kenya to Italy) and Asia (P. clarkii from Singapore to Cyprus together with ornamental fish).

The purpose in introducing O. limosus and P. leniusculus to Europe was mainly to replace A. astacus in former crayfish waters devastated by the plague, and P. clarkii mainly to stock rivers, canals, reservoirs and rice fields in Spain. Especially in Sweden and in Spain the introduction of P. leniusculus and P. clarkii have considerably increased the crayfish production and created new important forms of fishery (e.g. Westman 1982).

O. limosus is not as highly appreciated as other species for its flesh, but its high fecundity, disease resistance and tolerance of

Table 1. FRESHWATER CRAYFISH SPECIES IN EUROPE AND THEIR ORIGIN.

COUNTRY	SPECIES	ORIGIN
AUSTRIA	Astacus astacus	Native
	Astacus leptodactylus	Native in Eastern Austria. Introduced in Western Austria.
	Astacus pallipes	Native ?
	Astacus torrentium	Native
	Orconectes limosus	Introduced from Germany 1970
	Pacifastacus leniusculus	Introduced since 1970 from California and Sweden
BELGIUM	Astacus astacus	Native
	Astacus leptodactylus	Introduced from unknown place in 1960s.
	Orconectes limosus	Natural invasion from France and/or Germany about 1960.
	Pacifastacus leniusculus	Introduced from USA and Sweden 1979.
BULGARIA	Astacus astacus	Native
	Astacus leptodactylus	Native
CYPRUS	Astacus astacus	Introduced from Denmark 1976 and 1978.
	Pacifastacus leniusculus	Introduced from Sweden 1979 and 1980.
	Procambarus clarkii	Imported from Singapore 1983.
DENMARK	Astacus astacus	Native
	Astacus leptodactylus	Introduced
	Pacifastacus leniusculus	Introduced
FED. REP. GERMANY	Astacus astacus	Native
	Astacus leptodactylus	Imported from Turkey ?
	Cambarus affinis (Orconectes limosus)	Introduced from USA in 1980.
	Pacifastacus leniusculus	Introduced first 1973 from the River Columbia and the Lake Almanoe.
FINLAND	Astacus astacus	Native
	Astacus leptodactylus	First information of the species in 1977
	Pacifastacus leniusculus	Introduced from USA 1967-1969 and from Sweden several times in 1970's.
FRANCE	Astacus astacus	Native
	Astacus leptodactylus	Introduced from Turkey.
	Austropotamobius pallipes	Native in most parts of France.
	Orconectes limosus	Introduced from Germany at the beginning of this century.
	Pacifastacus leniusculus	Introduced from Sweden and USA.
GREECE	Astacus fluviatilis (Astacus astacus)	Native
	Astacus leptodactylus	Introduced
HUNGARY	Astacus astacus	Native
	Astacus leptodactylus	Native, also introduced.
	Astacus torrentium	Native
	Cambarus affinis (Orconestes limosus)	Introduced in 1960.
IRELAND	Austropotamobius pallipes	Presumed native but it may have been imported from UK in 19th century.

COUNTRY	SPECIES	ORIGIN
ISRAEL	No freshwater crayfish species	
ITALY	Astacus astacus	Native
	Astacus leptodactylus	Introduced from Turkey during the last 10 years.
	Astacus pallipes	Native
	Procambarus clarkii	Introduced from Kenya in 1983 for experimental breeding.
NETHERLANDS	Astacus astacus	Native
	Astacus leptodactylus	Imported from Turkey as gourmet food and may have escaped. First certain find in 1977.
	Orconectes limosus	Immigrated from Germany, Belgium and France. Found for the first time in 1969.
	Procambarus clarkii	Sold in the aquarium trade and escaped(?)
NORWAY	Astacus astacus	Immigrated or introduced from Sweden in ancient times.
POLAND	Astacus astacus	Native
	Astacus leptodactylus	Introduced from Russia at the beginning of this century.
	Orconectes limosus	Introduced from Germany about 1890.
	Pacifastacus leniusculus	Introduced from USA 1972.
PORTUGAL	Austropotamobius pallipes	Native
	Procambarus clarkii	Introduced
SPAIN	Astacus leptodactylus	Introduced from Turkey 1975.
	Astacus pallipes pallipes	Native
	Pacifastacus leniusculus	Introduced from Sweden 1974.
	Procambarus clarkii	Introduced from USA 1974.
SWEDEN	Astacus astacus	Native
	Pacifastacus leniusculus	Introduced from USA in 1960-1969.
SWITZERLAND	Astacus astacus	Introduced or may have been native in some parts of the country.
	Astacus leptodactylus	Introduced probably after 1972.
	Austropotamobius pallipes	Native
	Austropotamobius torrentium	Native
	Orconectes limosus	Introduced probably after 1972.
TURKEY	Astacus leptodactylus	Native
UNITED KINGDOM	Astacus astacus	Introduced from Bavaria
	Astacus leptodactylus	Introduced from Eastern Europe.
	Austropotamobius pallipes	
	Cherax quadricarinatus	Introduced
	Pacifastacus leniusculus	Introduced from Sweden.
U.S.S.R.	Astacus astacus	Native
	Astacus leptodactylus	Native
	Pacifastacus leniusculus	Introduced from unknown place 1972.
YUGOSLAVIA	Astacus astacus	Native
	Astacus leptodactylus	Native
	Astacus pallipes	Native
	Astacus torrentium	Native

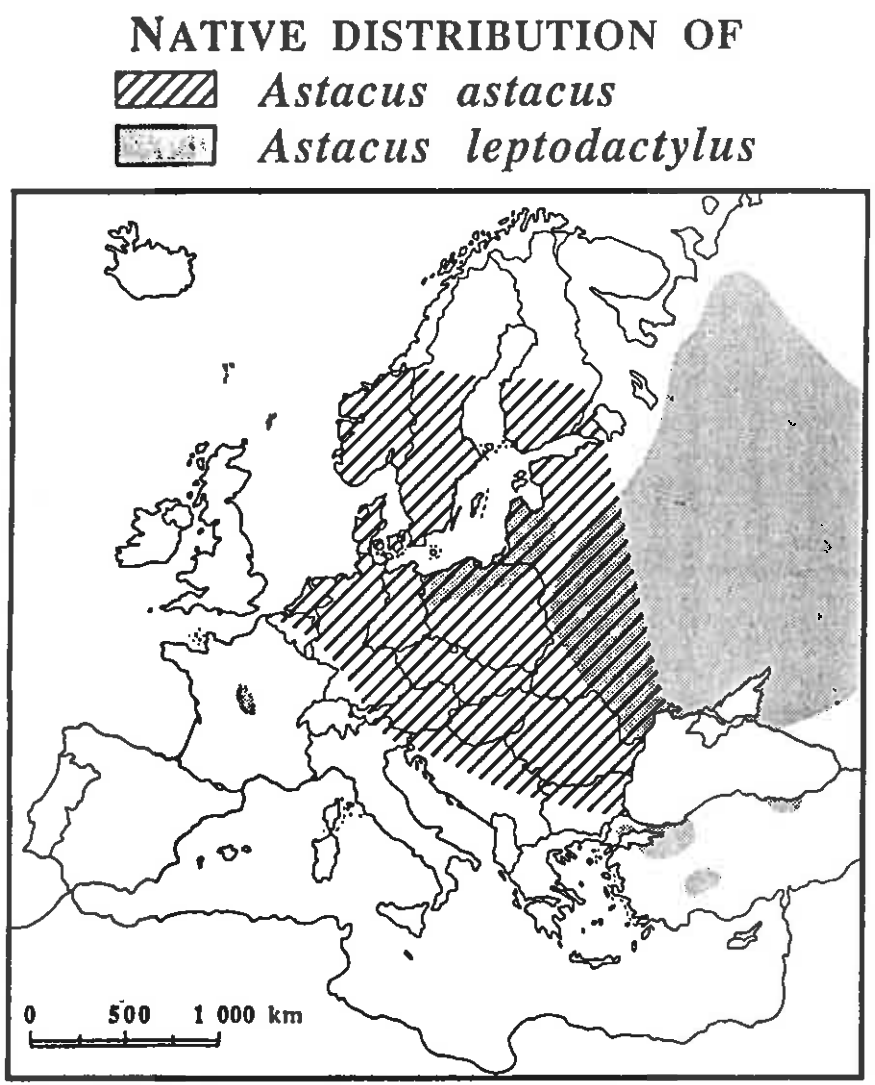

FIGURE 1. The distribution of **Astacus astacus** (Cukerzis 1988) and **A. leptodactylus** (Köksal 1988) according to Ackefors (1989).

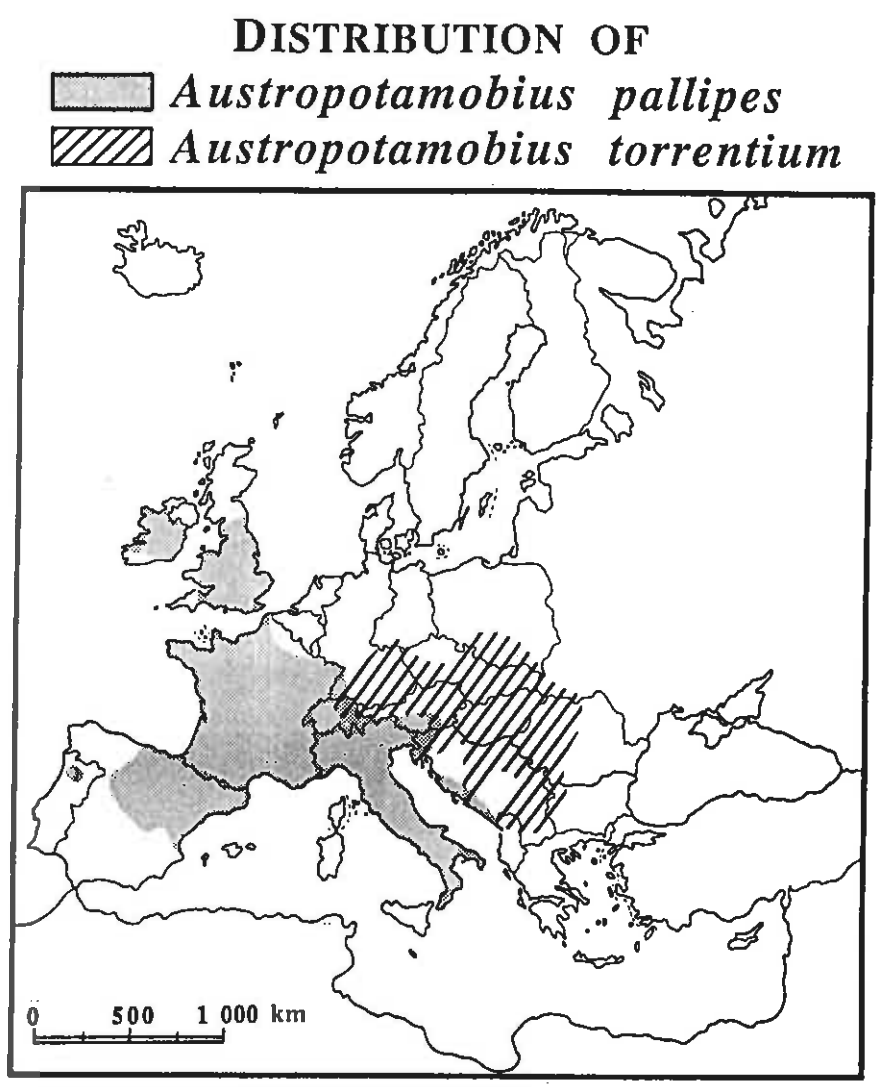

FIGURE 2. The distribution of **Austropotamobius pallipes** and **A. torrentium** (Laurent 1988) according to Ackefors (1989).

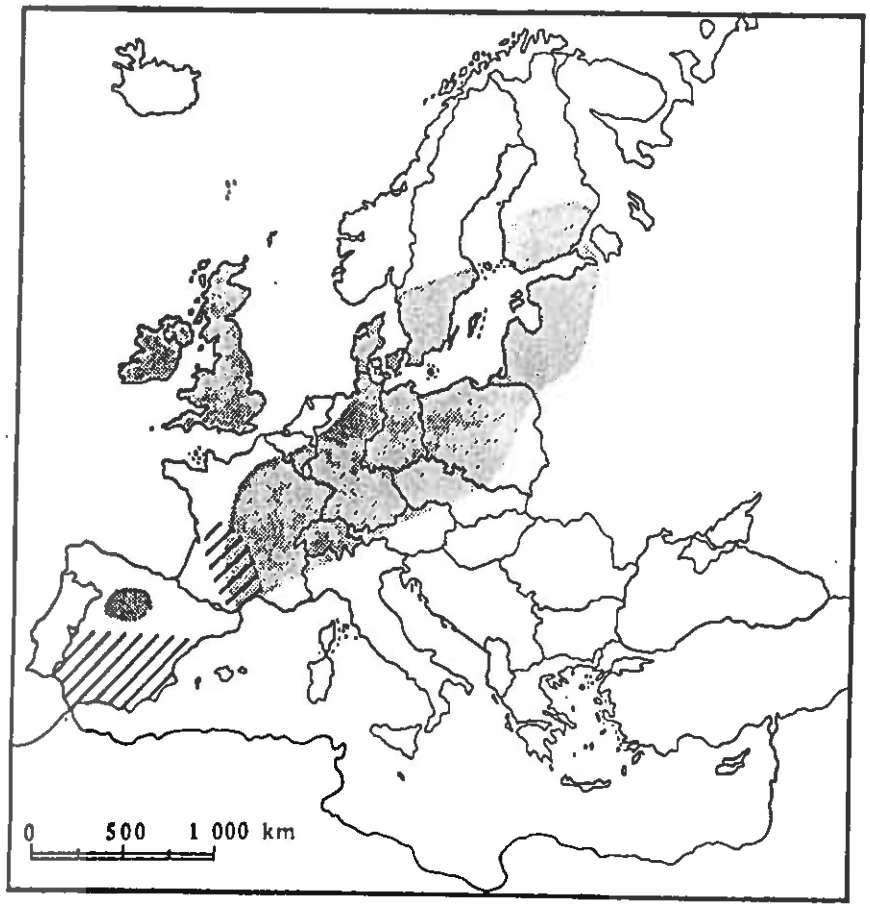

FIGURE 3a. Introduced American crayfish species in Europe. I. The distribution of Pacifastacus leniusculus and Procambarus clarkii (Holdich and Lowery 1988) according to Ackefors (1989).

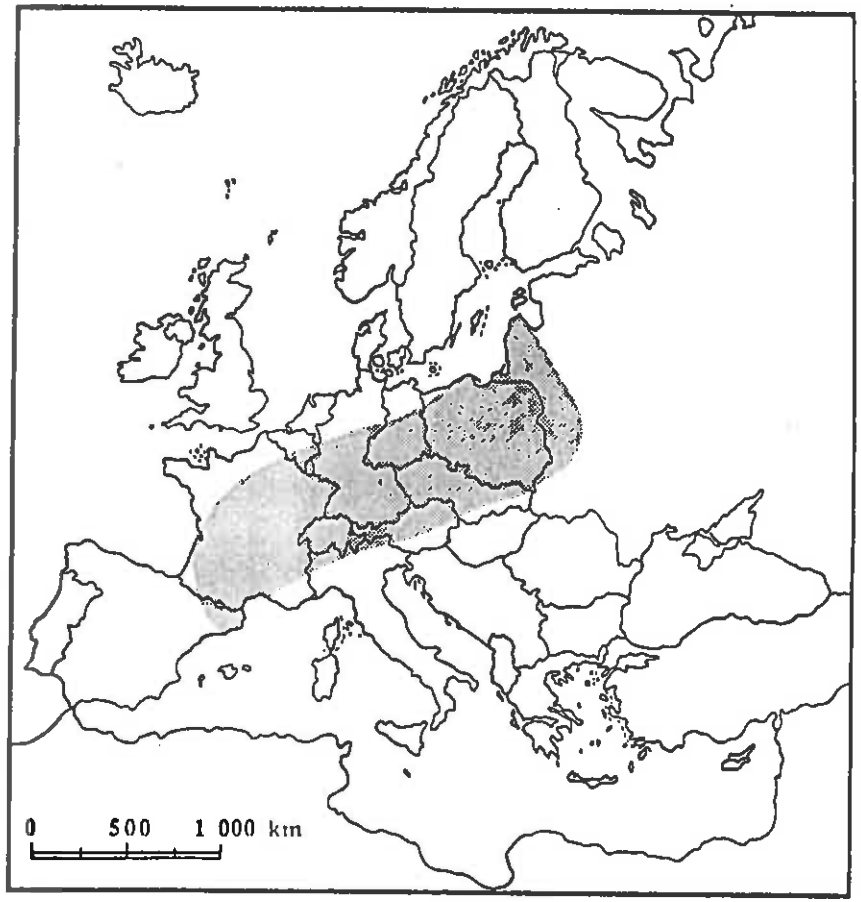

FIGURE 3b. Introduced American crayfish species in Europe. II. The distribution of Orconectes limosus (Holdich and Lowery 1988) according to Ackefors (1989).

deoxygenated and polluted waters have contributed to its rapid spread (Welcomme 1988).

There are approximately 300 freshwater crayfish species in North and Central America, but for the most part these crayfish have several outstanding negative features. For example, they are mobile, aggressive, tolerant to wide range of habitat conditions, and thus capable of spreading rapidly within a wide range of living conditions; omnivorous and so have a wide trophic spectrum; often excellent accumulators of heavy metals and pesticides; host to a wide range of commensals and epizootics; competitive, cannibalistic and feed on fish, and in consequence highly likely to carry spores and viruses of fish and crayfish diseases into new environments (e.g. Westman 1982). Consequently, there is a great need for adoption of procedures to reduce the risk of adverse effects arising from the introduction or transfer in inland crayfish species.

In the last few years, an increasingly cautious approach had been adopted to the introduction of exotic species. Several international organizations, including th International Council for the Exploration of the Sea (ICES), the FAO European Inland Fisheries Advisory Commission (EIFAC) and the International Union for the Conservation of Nature and National Resources (IUCN), have issued recommendations concerning introductions of new species, advising that stocking be subject to tighter controls. EIFAC adopted a Code of Practice based on the ICES model at its Fourteenth Session (Bordeaux, France, 1988). All other FAO Regional Fishery Bodies dealing with inland waters have also expressed their concern about intoductions at their sessions and are currently investigating the relevance of the ICES/ EIFAC Code to their own situations (Welcomme 1988).

Registers and reviews of fish and crayfish stockings and of their results and effects have also been drawn up under the auspices of, for instance, FAO and EIFAC and the European Mariculture (Aquaculture) Society (e.g. Rosenthal 1987, Welcomme 1988) as well as on a country basis (e.g. Westman and Pursiainen 1984, Westman and Tuunainen 1984).

3. Changes in the occurrence and distribution of native freshwater crayfish species in Europe.

The plague **Aphanomyces astaci**, which in all probability reached Europe via introduced American species, has been causing great damage to native crayfish populations since 1860. It now occurs in almost all countries in our continent. Its most recent advance was into the British Isles, where it arrived, along with signal crayfish, in 1983, and into Norway in 1987 (Fig. 4.)

Besides the plague, certain other diseases (Table 2) and the effects of human activity have also caused serious damage to freshwater crayfish stocks in Europe. Changes in the occurrence of native species in the EIFAC region, as revealed by our inquiries, are shown in Table 3.

With the exception of one country (Yugoslavia), populations of **A. astacus** and **A. pallipes** have dwindled everywhere and are still in decline. The situation in the case of **A. leptodactylus** appears to be only a little better; populations of this species have even increased in one country (the Federal Republic of Germany). The catastrophic decline which the plague caused in Turkey's high-yielding stocks of **A. leptodactylus** in the mid-80s was the worst sudden blow to European crayfish populations for decades.

With all species and in all countries, the factors causing declining crayfish populations are the same: plague, other diseases, pollution, man-made environmental changes and overfishing. A further contributory factor mentioned in the case of the Federal Republic of Germany is intensive eel stocking, which has reduced populations of **A. leptodactylus** in some areas. Similar observations have been made in Sweden with respect to **A. astacus**.

In a number of European countries it has been repeatedly observed that various types of engineering operations (e.g. clearing, canalizing, dredging and embanking of rivers, changing of river beds, damming of rivers, construction of reservoirs, regulation of water levels and stream flows, and forest ditching) have caused, both directly and indirectly, great damage to freshwater crayfish stocks (Westman 1985). The crayfish is naturally very sensitive to changes in water quality and other factors, particularly as it is a slow-moving bottom dweller, confined to a relatively narrow littoral

TABLE 2.Freshwater crayfish parasites and diseases observed in European countries.

COUNTRY / DISEASE	AUSTRIA	BELGIUM	BULGARIA	CYPRUS	DENMARK	FRG	FINLAND	FRANCE	GREECE	HUNGARY	IRELAND
BACTERIA:											
Pseudomonas fluorescens		No information	No diseases ever observed					+			
Ps. putida								+			
Ps. sp								+			
Aeromonas hydrophila								+			
FUNGI:											
Saprolegnia sp								+			
Fusarium roseum								+			
F. solani								+			
F. sp								+			
Dichtychus sp								+			
Ramularia astaci					+	+	+				+
Didymaria cambari						+					
Aphanomyces astaci	+					+	+	+	+	+	+
Achyla prolifera					+						
Cephalo-sporium leptodactyli											
Psorospermium haeckeli							+	+			
PROTOZOA:											
Thelohania contejeani					+	+	+	+			+
HELMINTHS:											
Branchiob-della sp				+	+	+		+		+	
Trematoda					+						

DISEASE / COUNTRY	ITALY	NETHER-LANDS	NORWAY	POLAND	PORTUGAL	SPAIN	SWEDEN	SWITZERLAND	TURKEY	U.K.	YUGOSLAVIA
BACTERIA:											
Pseudomonas fluorescens Ps.putida Ps. sp	+	No information					No information				
Aeromonas hydrophila	+					+					+
FUNGI:											
Saprolegnia sp			+	+	+	+	+		+	+	+
Fusarium roseum F. solani F. sp	+										
Dichtychus sp											
Ramularia astaci											
Didymaria cambari											
Aphanomyces astaci											
Achyla prolifera prolifera	+										
Cephalo-sporium leptodactyli				+			+				
Psorospermium haeckeli			+	+			+			+	+
PROTOZOA:											
Thelohania contejeani				+			+				+
HELMINTHS:											
Brancihiob-della sp				+			+				+
Trematoda											

THE SPREAD OF THE CRAYFISH PLAGUE *Aphanomyces astaci*, IN EUROPE

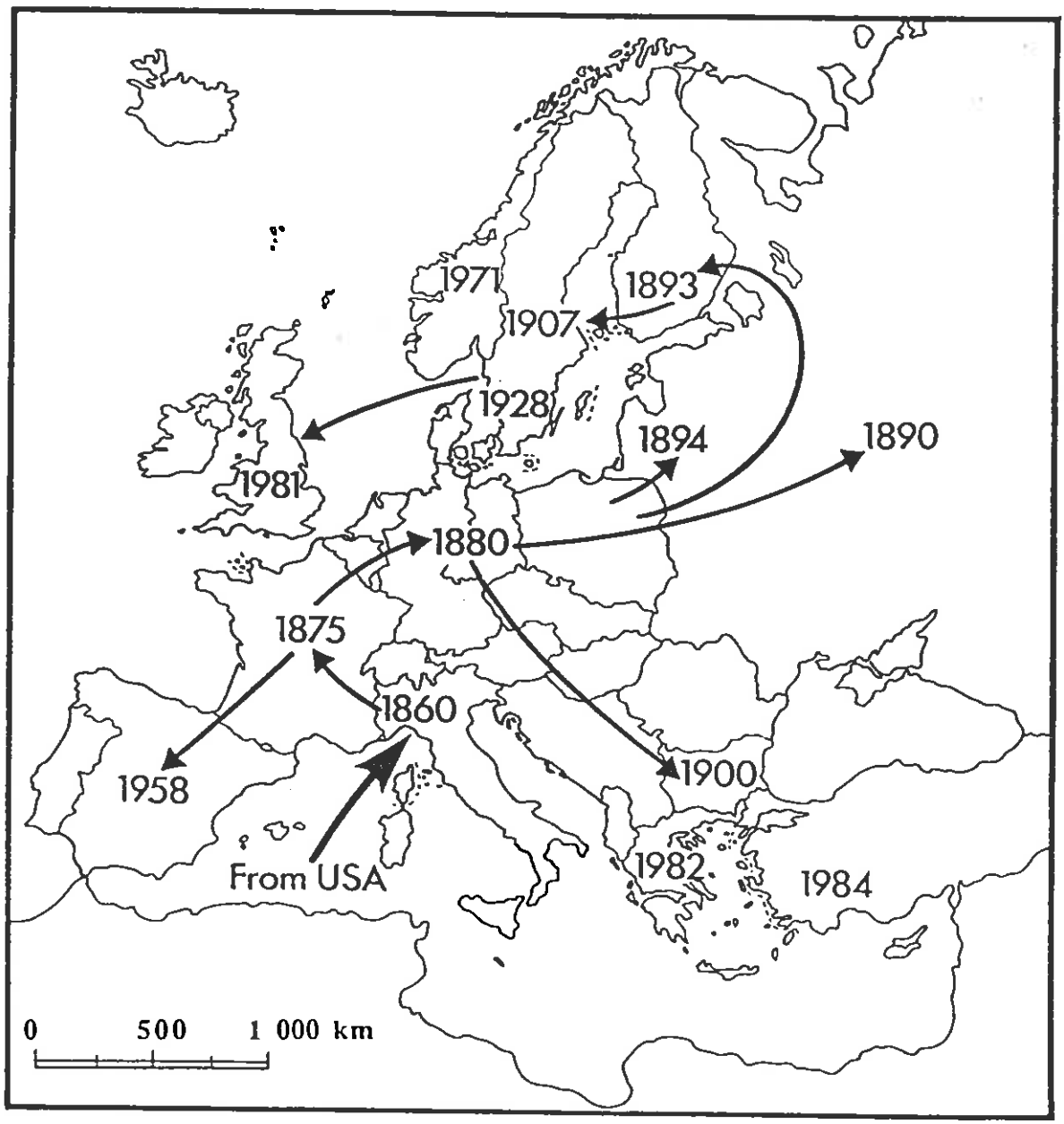

FIGURE 4. The spread of the crayfish plague, Aphanomyces astaci, in Europe according to Ackefors (1989).

TABLE 3. CHANGES IN ABUNDANCE AND DISTRIBUTION OF NATIVE FRESHWATER CRAYFISH SPECIES IN EUROPE.

1. Astacus astacus

Austria:	Decreased
Bulgaria:	Decreased
Fed. Rep. Germany:	Increasing stocks
Finland:	Decreased
France:	Decreased
Greece:	Decreased
Hungary:	Decreased
Netherlands:	Decreased
Sweden:	Decreased
Yugoslavia:	Decreased in some areas and rapid expansions in some areas

REASONS FOR CHANGES:

Crayfish plague	In all countries
Pollution	- " -
Man-made environmental changes	- " -
Catch	- " -

2. Astacus leptodactylus

Bulgaria:	Pollution, water blooming
Fed. Rep. Germany:	In general increasing stocks, but locally decreasing
France:	Extending
Hungary:	No significant changes
Netherlands:	Evidently increasing
Spain:	Disappeared
Turkey:	Decreased since 1985

REASONS FOR CHANGES:

Intensive eel stocking	Fed. Rep. Germany
Crayfish plague	Fed. Rep. Germany, Turkey
Overfishing	Fed. Rep. Germany
Man-made environmental changes	Fed. Rep. Germany
Pollution	Fed. Rep. Germany, Bulgaria
Diseases	Fed. Rep. Germany

3. Astacus pallipes

France:	Continuosly decreasing
Italy:	Decreased in Central Italy
Spain:	Decreased
United Kingdom:	Decreased
Yugoslavia:	No evident changes

REASONS FOR CHANGES:

Pollution	France, Italy, Spain
Overfishing	France, Spain
Diseases	France, Italy, Spain
Organic effluent	UK
Poaching	Italy
Man-made environmental changes	Italy, Spain, UK

zone. This makes it vulnerable to many engineering activities, especially if they result in a sudden deterioration in the habitat.

Construction work frequently causes long-term turbidity in the water, with an increase in suspended solids and iron content, acidification, and a decrease in dissolved oxygen content downstream. All of these things are considered especially deleterious to crayfish. Along with the more-or-less temporary changes in water quality that construction causes, prolonged or permanent alteration of habitats are, naturally, more detrimental.

Evidence of the adverse effects of habitat modification is varied and includes mortality, emigration, reduction in growth rate and production, and impairment of reproduction. The adverse effects do not generally result from a change in one particular environmental factor. This makes the particular reasons for the damage very difficult to determine and hence also impedes the planning of restoration and managment measures. Furthermore, information relating to the combined effect of different environmental factors on crayfish stocks is very scarce (reviewed by Westman 1985).

4. Freshwater crayfish catches in Europe

Our inquiries indicated that the only data on catches available from most countries are estimates; more detailed statistical material does not exist. Besides, the plague, environmental changes and increased efforts to manage stocks mean that the situation is constantly in a state of, often rapid, flux. When the plague spread to Turkey, for example, it took only a year for the annual catch to plunge from over 6 000 to under 2 000 tonnes.

Table 4 sets forth annual catches and prices per kilogramme in various countries. Although inquiries did not elicit data from all countries, information was obtained from the most important producer countries.

In Europe, three native crayfish species (A. astacus, A. leptodactylus and A. pallipes) and three introduced species (P. leniusculus, P. clarkii and O. limosus) are caught commercially. In order of volume, total catches of various species are as follows (in tonnes per year):

P. clarkii	**4 655**
A. leptodactylus	**2 590**
P. leniusculus	**200**
A. astacus	**180-200**
O. limosus	**10**
A. pallipes	**4**
Not specified	**74**

Since the collapse of **A. leptodactylus** in Turkey, **P. clarkii** accounts for clearly the largest catch of any species in Europe, nearly double that of its closest rival, **A. leptodactylus**. Nearly all **P. clarkii** are produced in Spain. Portugal produces a small, but growing volume. Production of **P. clarkii** has grown astonishingly fast, because the species was introduced into Spain only in the mid-70s.

A. leptodactylus accounts for the second-biggest catch, over 2 500 tonnes. The plague notwithstanding, Turkey remains the largest producer. Estimates of the USSR's production of this species vary from 200 to 1 000 tonnes. In any event, the country contains considerably unexploited crayfish resources and interest in exploiting them is growing rapidly.

Catches of **A. astacus** and **P. leniusculus** are of approximately the same magnitude, 200 tonnes each. The former (the noble crayfish) is caught in most European countries, with Finland, Sweden and Norway boasting the lagest catches. By contrast, nearly all **P. leniusculus** are caught in a single country, Sweden, where catches have been increasing strongly in recent years. The present catch of this species (7 million specimens, 200 tonnes) is four times that of the native **A. astacus** (1.5 million specimens, 50 tonnes). The signal crayfish has proved very productive, as the catch is taken from only a few hundred relatively small lakes. Moreover, probably only a few populations of this creature have so far reached their carrying capacity in the whole water body.

On the basis of the data available, it would appear that the crayfish catch yield from natural water bodies is about 7 714 tonnes a year, or 250-350 million individuals. Since data for some countries are lacking, the real catch might well be in the region of 8 000 - 8 500 tonnes.

TABLE 4. FRESHWATER CRAYFISH CATCHES AND PRICES IN EUROPE.

COUNTRY	SPECIES	CATCHES number of specimens	CATCHES kg	PRICE per kg	REMARKS
AUSTRIA			1983: 3 000-5 000		
BELGIUM	A. astacus				Catching of A. astacus in public waters is prohibited by law 1987-1992
BULGARIA	A. astacus A. leptodactylus	50 000-100 000			
FRG			1961: 10 688 1984: 9 600		5 states in Berlin and Schleswig-Holstein
FINLAND	A. astacus P. leniusculus	1986: 3.4 mill. 1987: 2 000	110 000 70	81 US$ 90 US$	
FRANCE	O.limosus		1981: 45 1982: 68 1983: 1 393 1984: 719 1985: 501 1987: 10 000 (total)	 27-30 US$	1981, 1982 Lake Annecy 1983-1985 Lakes Annecy and Bourget
HUNGARY	A. astacus		1956: 13 000 1986: 1 000	 3.5 US$ (export)	
IRELAND	A. pallipes	1987: 4 500	100	12 US$	
NORWAY	A. astacus		20 000-40 000		
POLAND	A. astacus A. leptodactylus		1986: 2 700 1987: 3 450 1986: 700 1987: 1 700	0.8-1.6 US$	
PORTUGAL	A. pallipes P. clarkii	1986: 10 000 1986: 50 000	> 1 000 > 5 000	5-10 US$ 2-3 US$	
ROMANIA			1984: 18 000		
SPAIN	A. pallipes P. clarkii	 1986: 130 mill.	1986: 3 000 1986: 3 384 000 1987: 4 650 000	19 US$ 1.7-7.7 US$	
SWEDEN	A. astacus P. leniusculus	1987: 1.5 mill. 1987: 7 mill.	50 000 200 000	26-68 US$ 26-65 US$	
TURKEY	A. leptodactylus		1985: 6 244 000 1986: 1 585 000	2.2 US$ 3.9 US$	
UNITED KINDOM	P. leniusculus		1988: 6 000-8 000		
U.S.S.R.	A. leptodactylus		1 mill. (?)		
YUGOSLAVIA			1986: 43 000	6 US$	

Prices vary considerably by species and from one country to another (see Table 4). Fishermen receive the highest prices (up to $80-90 a kilogramme) for A. astacus and P. leniusculus in Finland and Sweden. In Sweden, where it is caught in the largest volume, the signal crayfish fetches the same price as the noble crayfish.

The price received for A. pallipes varies from $5-19 per kilogramme. A. leptodactylus was fetching $2.2 in Turkey, then the leading producer of this species, in 1985, but the price had nearly doubled a year later owing to the decline in catches.

In Spain, the price received for P. clarkii varied from $1.7 to 7.7 per kilogramme in 1987. Although the catch of P. clarkii was almost 12 times as great as that of A. astacus and P. leniusculus combined, its estimated value (about $20 million at the average price) was only about double the figures for A.astacus ($9 million or so) and P. leniusculus (approximately the same).

The total value of the A. leptodactylus catch is $6-7 million. Catches of all crayfish species in Europe currently bring fishermen at least $45 million a year.

A point worth noting is that the species introduced into Europe (P. leniusculus and P. clarkii) boast both markedly higher catch totals (about 1.7 times) and greater catch values (about 1.9 times) than native species. The main explanation for this is the major damage caused to native stocks by the plague.

The numbers of freshwater crayfish fishermen in various European countries are shown in Table 5. Except in Turkey and Spain, the numbers of professional fishermen are very small. This is understandable, since in most countries crayfish may be caught only during certain, usually brief, seasons. By contrast, there are considerably larger numbers of semi-professional crayfish fishermen in several countries. Most fishermen are recreational and their catches are intended for their own consumption. They vary in number from a million or so in Spain to only a handful in other countries.

4. Crayfish culture

Inquiries reveal that freshwater crayfish are farmed in at least the following European countries: Austria, the Federal Republic of

TABLE 5. NUMBER OF FRESHWATER CRAYFISH FISHERMEN IN EUROPE.

COUNTRY	Professional fishermen	Semi-professional fishermen	Recreational fishermen
AUSTRIA	-	1	50 - 100
BELGIUM	?	?	?
BULGARIA	?	?	?
CYPRUS	-	-	some
DENMARK	-	-	10
FED. REP. GERMANY	6	40 - 50	40 - 50
FINLAND	-	1 000 - 5 000	100 000
FRANCE	5-10	a few	impossible to evaluate
GREECE	-	25	-
HUNGARY	-	10	-
IRELAND	-	1 (?)	10 - 20
ISRAEL	-	-	-
ITALY	-	-	some thousand
NETHERLANDS	-	-	-
NORWAY	-	10 - 15	10 000 - 15 000
POLAND	-	30	impossible to evaluate
PORTUGAL	-	-	impossible to evaluate
SPAIN	700-750	13 000	1 mill.
SWEDEN	< 5	< 100	3 000 - 5 000
SWITZERLAND	-	1	?
TURKEY	1985: 6 000 1986: 4 000		
UNITED KINGDOM	-	12	?
YUGOSLAVIA	-	?	?

Germany, Finland, France, Ireland, Italy, Norway, Spain, Sweden, the United Kingdom and the USSR. According to respondents, crayfish culture are not practised in Belgium, Cyprus, Denmark, Hungary, Poland, Portugal, Czechoslovakia or Yugoslavia (Table 6).

In most of the countries where crayfish are being cultured, operations are still on a trial basis and small scale. Production data were received from only a few countries (Table 7).

Sweden, where there are more than 400 farms, leads the rest of Europe in culturing freshwater crayfish. Production of **A. astacus** and **P. leniusculus** hatchlings exceeds one million. Most of them are released into former crayfish waters or sold abroad (signal crayfish). Production for consumption as food is growing rapidly in Sweden.

There are some 45-55 farms in Finland and the number is increasing rapidly. Some 350 000 hatchlings are now being produced each year. Nearly all are reared into one-summer juveniles for stocking purposes. Production for consumption as food is still only on a trial scale.

In Spain, culture in the actual sense of the word is conducted at only a few farms. The remainder of the catch is obtained mainly from rice-growing areas.

The United Kingdom appears to have about 100 farms, which mainly produce **P. leniusculus** for both stocking and consumption. In 1982, producers established the Crayfish Marketing Association to ensure high-quality products and maintain price levels by avoiding dumping and price-cutting.

Large number of **A. astacus** and **A. leptodactylus** hatchlings have long been produced in the Lithuania SSR for stocking purposes.

Table 8 shows rearing space and feeding in various European countries.

5. Crayfish trade

Data on European countries' imports and exports of crayfish are shown in Table 9. Sweden and France are the major European con-

TABLE 6 SPECIES CULTIVATED AND THE PURPOSE OF CULTIVATION

COUNTRY	SPECIES	THE PURPOSE OF CRAYFISH CULTIVATION
Austria		- to produce stocking material - to produce crayfish for consumption
Bulgaria		- no culture at present (3
Cyprus (1		- to establish a local broad stock which will provide stocking material - to establish methods of culture which will allow their commercial exploitation
Denmark		- to produce stocking material
Fed. Rep. Germany		- to produce stocking material - to produce crayfish of edible size
Finland	Astacus astacus Pacifastacus leniusculus	- stocking, rearing for consumption has been started - - " -
France	Astacus astacus Astacus leptodactylus Pacifastacus leniusculus	- to provide stocking material (one crayfish farm) - there has been one crayfish farming experiment, but failed and stopped. Production of juveniles for stocking. - to produce material for stocking
Greece		- no crayfish cultivation procedures running
Hungary		- exept for one occasion in 1965 no effort for propagation has been carried out
Ireland		- several salmonid fish farmers have expressed interest in experimental culture of crayfish but the economics seem unattractive (2
Italy	Astacus pallipes, Astacus leptodactylus	- to produce material for stocking
	Procambarus clarkii	- its breeding is planned in controlled enviroments only

Netherlands		- no culture
Norway	Astacus astacus	- to produce stocking material - to produce crayfish for consumption
Poland	Astacus astacus, Astacus leptodactylus	- scope of these, always sporadic, attempts was the production of stocking materials
	Occonectes limosus	- no culture
Spain	Astacus pallipes	- to maintain the stocks - to provide stocking material
	Procambarus clarkii	- is cultivated for commercial purposes
	Pacifastacus leniusculus	- to produce stocking material
Sweden	Astacus astacus	- to produce stocking material and crayfish for consumption
	Pacifastacus leniusculus	- " - - " -
Switzerland		- no crayfish culture
United Kingdom	Austropotamobius pallipes	- to produce stocking material
	Pacifastacus leniusculus	- juveniles are sold for further growing to an eatable size
Yugoslavia		- no culture

1) Due to the unfavourable results given by A. astacus the culture and stocking of this species was a bandonded. The hatchery Work for the production of young P. leniusculus for the stocking of inland waters, has also stopped because of problems encountered with the loss of eggs by the berried females.

2) There is one person who runs a small holding - feeding facility. Crayfish are collected from surrounding waters and held in mesh cages in a small lake.

3) There was one earlier (1980-1983) experiment carried out in order to grow market size crayfish (A. leptodactylus) and this experiment will be renewed as soon as possible.

TABLE 7. CRAYFISH CULTIVATION

COUNTRY	SPECIES	NUMBER OF FARMS	NUMBER OF TANKS/PONDS	AREA m^2	PRODUCTION NEW. HATCH.	PRODUCTION STOCKING (one summer juv.)	CONSUMPTION
AUSTRIA	A. astacus	2			Few thousand		
FINLAND	A. astacus	30-35			300 000	250 000	
	P. leniusculus	15-20			50 000	20 000	
FRG	A. astacus	10		ponds 10-20 ha	10 000		3 000-5 000
	P. leniusculus			basins 100-300 m^2			
FRANCE	A. astacus	1			--------- t o t a l 1 0 t n ----------		
	P. leniusculus	1					
IRELAND	A. pallipes	2	3	5 000			
SPAIN	P. clarkii[1]		-	58 000 ha [1]			4 754 tn
	P. leniusculus	1			20 000	15 000	800
	A. pallipes	1	8				
SWEDEN	A. astacus	54	1 800	540 000	100 000	10 000	100 000
	P. leniusculus	351	11 700	3.5 mill.	1 mill.		500 000
UNITED KINGDOM	A. pallipes				-------- l e s s t h a n 1 0 t n -------		
	P. leniusculus						
	A. leptodactylus	1987: 38					
		1990: 62					
		1990: 1					

1) Extensive cultivation. Crayfish are caught mainly from rice paddies flooded annually but also from rivers, canals, reservoirs etc.

TABLE 8. CRAYFISH CULTURE - REARING SPACE AND FEEDING

COUNTRY	FEEDING	REARING SPACE
AUSTRIA	Bruised grain, fish, organic waste products, pellets, vegetables [2]	Specific crayfish ponds, carp, ponds, natural waters, dredged lakes
CYPRUS	Pellets, fish[1], vegetables [3], waterplants, leaves[5]	Hatchery trays, fibreglass basins, tanks, troughs. 1987: no cultivation at present
FED. REP. GERMANY	Apples, fish, vegetables[2]	Earthen ponds, basins
FINLAND	Natural benthos, fish, leaves[6], plankton[7]	Fibreglass basins, earthen ponds
FRANCE	Fish, pellets, corn, wheat	Concrete basins, earthen ponds
IRELAND	Fish	Mesh-cages in a lake
ITALY	Natural benthos, pellets, rice, earthworms, vegetables[2], fish	Concrete basins, earthen ponds
NORWAY	Vegetables, fish	Concrete basins, stainless steel basins (hatchery)
SPAIN		Earthen ponds, basins, raceways
SWEDEN	Organic waste products, pellets[4]	Earthen ponds
UNITED KINGDOM	Pellets, macrophytes, animal material, algal material[7], boiled vegetables[7]	Trout ponds, plastic and fibreglass tanks

1) Juveniles: Mosquito fish Gambusia affinis
2) Potatoes, carrots etc.
3) Mostly trout pellets
4) Pacifastacus leniusculus
5) Leaves of Alnus orientalis
6) Leaves of Alnus glutinosa
7) To juveniles

TABLE 9. CRAYFISH IMPORT AND EXPORT.

COUNTRY	SPECIES	I M P O R T	E X P O R T
BELGIUM	A. leptodactylus	200 000 kg [1]	35 000 kg (re-export)[1]
DENMARK		40 000 kg	
FINLAND	A. leptodactylus	30 000 kg	
	P. leniusculus	35 000 kg	
FRANCE		2 mill. kg	
HUNGARY	A. astacus		200 kg [1]
NORWAY			10 000 - 15 000 kg (re-export)
POLAND	A. astacus		1986: 2 650 kg [1]
			1987: 2 850 kg
	A. leptodactylus		1986: 680 kg [1]
			1987: 1 700 kg
SPAIN	A. leptodactylus	5 000 kg [1]	
	A. pallipes		1986: 120 000 kg [1]
			1987: 90 000 kg
	P. leniusculus	2 000 specimens (1980)[2]	
	P. clarkii		1986: 70 000 kg [1]
			1987: 1.5 mill. kg
SWEDEN	A. astacus	12 000 kg [1]	
	A. leptodactylus	521 000 kg [1]	
	P. leniusculus	25 000 kg [1]	40 000 specimens [3]
	P. clarkii	1.5 mill. kg [1]	
SWITZERLAND		30 000 - 40 000 kg	
TURKEY	A. leptodactylus		1985: 5.3 mill. kg
			1986: 1.3 mill. kg
UNITED KINGDOM		5 000 kg	
WEST-GERMANY		200 000 kg	
YUGOSLAVIA			some live crayfish [1]

1) for consumption
2) for rearing
3) newly hatch, for stocking and rearing

sumers. Each imports about 2 000 tonnes a year, mainly P. clarkii and A. leptodactylus. Other significant importers are Belgium and the Federal Republic of Germany, 200 tonnes each.

The largest exporter is Spain (1 590 tonnes). Turkey's exports, which were of considerable economic importance to the country, collapsed from about 5 300 tonnes in 1985 to about 1 300 tonnes the following year.

Europe also imports over 1 500 tonnes of crayfish a year from the USA. The most important species are P. leniusculus and P. clarkii.

Major changes are continually taking place in the crayfish trade. Some stocks are declining due to overfishing, plague and environmental changes, whilst new stocks are beginning to yield catches, especially in eastern Europe. The introduction of new species, especially P. leniusculus and P. clarkii, into new areas and the rapid development of crayfish culture will certainly have a strong influence on the European crayfish trade before long.

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QUESTIONNAIRE ON THE STATUS OF CRAYFISH FISHERIES IN THE EIFAC REGION

I SPECIES, ORIGIN, GEOGRAPHICAL DISTRIBUTION

1. Nomenclature

   1.1. Scientific name(s)

   1.2. Common names(s) (also translated into English)

2. Origin of the species

   2.1. Native

   2.2. Introduced (from where, when, for what purpose)

3. Distribution

   3.1. Geographical distribution (preferably on map)

   3.2. A general description of the habitats (e.g. brooks, rivers, lakes, glacial lakes, bogs, basins - mountain areas, plains - deep, shallow, fast or slow flowing waters)

   3.3. Determinants of distribution (temperature, substrate, diseases and parasites, exploitation, competion or predation, pollution)

   3.4. Changes in distribution during the last ten years and/or earlier

   3.5. Frequency in the distribution area (0-25 %, 25-50 %, 50-75 %, 75-100 % of waters)

3.6. Hybridization (hybrids, species with which hybridization occurs)

II POPULATION

1. Abundance and density of the population

1.1. Average abundance in the distribution area (sparse, rather sparse, fairly abundant, abundant - preferably on map, if possible)

1.2. Estimates of population size and density in different habitats (scarce, rather scarce, fairly dense, dense, or as number of crayfish per 1 m^2 of 100 m^2 in niche)

1.3. Changes in abundance in different habitats during the last ten years and/or earlier

1.4. Reasons for the changes in abundance

III EXPLOITATION

1. Fishermen

1.1. Number of professional fishermen (more than 50 per cent of income from crayfish catching)

1.2. Number of semi-professional fishermen (selling their catches)

1.3. Number of subsistence and recreational fishermen

2. Basis for the crayfish fisheries

2.1. Crayfish catching is free

2.2. The owner of the water area can catch crayfish

2.3. Catching areas can be hired

2.4. Other basis, what?

3. Fishing methods and equipment

3.1. Methods, their distribution and importance (hand picking, picking with various types of equipment, traps, balances, - baits and other lures, - auxiliary apparatus or methods)

3.2. Fishing equipment (type, size, mesh size and other information about traps, balances or other implements)

4. Since when has the species been exploited?

5. Fishing seasons

5.1. Fishing season(s) (dates of beginning, peak and end of season(s))

5.2. Variation in date or duration of season

6. Fishing operations and results

6.1. Catches per unit fishing effort (details of unit used) or per unit area

6.2. Degree of exploitation in various stocks and in the whole country (light, moderate, heavy)

6.3. Catch statistics available (official statistics on the total annual catch, regional catch statistics, separate studies on catches, obligatory reports from fishermen, annual catch quotas, trade or foreign trade statistics)

6.4. Total annual catch (numbers and/or weight, mean weight should be given, - if estimated please give the basis for estimation)

7. Changes in catches and the reason(s) for the changes during the last ten years and/or earlier

IV VALUE OF CATCHES AND PROCESSING

1. Value of catches

2. Use of fishing areas (fishermen's own use, selling, other possible use)

3. Foreign trade (current imports and exports, trend of development)

V PROTECTION AND MANAGEMENT

1. Regulatory measures

   1.1. Limitation or reduction of crayfish fisheries (limits on number of fishing units or on total catches - daily, seasonal, annual)

   1.2. Protection of population (closed areas or seasons, limitation of size and efficiency of gear, restrictions based on size, sex or condition, e.g. females carrying eggs)

   1.3. Other legislative regulations

2. Control or alteration of the environment

   2.1. Physical features (flow, water levels, erosion and silting, habitat improvement, etc.)

   2.2. Chemical features (water pollution control, liming, fertilization, etc.)

   2.3. Biological features (parasites and diseases, predation and competition, population manipulation, etc.)

   2.4. Stocking (maintenance, transplantation or introduction)

3. Other measures

VI CRAYFISH CULTURE

1. The purpose of crayfish cultivation (e.g. to provide stocking material)

2. Methods

   2.1. Foods and feeding

   2.2. Basins, ponds, other space of cultivation

3. Intensity

   3.1. Production (numbers or weight, mean weight should be given)

   3.2. The number of cultivation establishments

   3.3. The size of the establishments

VII PARASITES AND DISEASES

Each disease and crayfish species separately

Virus diseases

Bacterial diseases

Fungal diseases

- Crayfish plague (**Aphanomyces astaci**)
- Burned spot disease (**Ramularia astaci, Cephalosporium leptodactyli, Didymaria cambari**)
- Others

Protozoan diseases

- White tail disease (**Thelohania contejeani**)
- **Psorospermium haeckeli**
- Others

Helminths

- **Branchiobdella sp.**

- Nematoda sp.
- Others

Tumors

Others

1. Crayfish species

2. Origin of the disease

2.1. Time of propagation

2.2 Propagated from

2.3. Means of propagation

3. Distribution

3.1. Geographical distribution or incidents per year

3.2. Prevalence in the distribution area

3.3. Changes in the distribution during the last few decades

4. Significance

4.1. Intensity of individual infection

4.2. Intensity of population infection

4.3. Significance to crayfish culture

5. Preventive measures and treatment

5.1. Legislation

5.2. Chemical treatment

5.3. Electric barriers, etc.

VIII Futher information

AUSTRIA

Michael R. Wintersteiger

I SPECIES, ORIGIN, GEOGRAPHICAL DISTRIBUTION

1.-2. Nomenclature and origin of the species (Table 1)

Table 1. Scientific and common names of the species. Origin of the species and if introduced the main purpose. (Number refers to the questionnaire. For complete questions, see the questionnaire.)

1.1. Scientific name(s)	1.2. Common name(s)/ in English	2. Origin of the species
Astacus astacus	Edelkrebs/ Noble crayfish Rotscherling/ "Redclaw"	Native
Astacus torrentium	Steinkrebs/ Stone crayfish	Native
Astacus pallipes	Dohlenkrebs/ Cave crayfish	Native ?
Astacus leptodactylus	Sumpfkreps/ Swamp crayfish	Native (?) in easter Austria. Introduced in Western Austria after 1880.
Orconectes limosus (Cambarus affinis)	Kamberkrebs/from: /Cambarus affinis	Introduced from Berlin to Salzburg (1970)
Pacifastacus leniusculus	Signalkrebs/ Signal crayfish	Introduced since 1970 from California and Sweden

3. Distribution

3.1. Geographical distribution of **Austropotamobius pallipes** is confined to the "Gitschtal", a valley in southwest of Carinthia.

Table 2. Determinants of distribution, changes in distribution, frequency in the distribution area and hybridization of crayfish.

Species	Max. summer temperature	Substrate	Exploitation	Changes in distribution	Frequency in the distribution area	Hybridization
Astacus astacus	20 - 25°C	Slow flowing brooks and rivers, lakes, ponds, hiding places, low pollution, no eel.	Yes	Falling	0 - 25 %	Not observed
Astacus torrentium	15 - 20°C	- " -	Seldom	Falling	- " -	- " -
Astacus pallipes	15 - 20°C	- " -	No	Not observed	- " -	- " -
Astacus leptodactylus	20 - 25°C	- " -	No	Not observed	- " -	- " -
Orconectes limosus	20 - 25°C	- " -	No	Not observed	- " -	- " -
Pacifastacus leniusculus	about 25°C	- " -	Yes	1983: the species was living in about 100 waters, increasing	- " -	- " -

II POPULATION

1. Abundance and density of the population

Abundance and density of the populations is variable. If the population density is high, the average number of the individuals may go up to more than 1 ind. per 1 m^2.

1.1. Density of **Pacifastacus** populations is sometimes extremely high (more than 10 ind./m^2).

III EXPLOITATION

1. Fishermen

1.1. No professional fishermen.

1.2. Only one semi-professional fisherman.

1.3. Number of subsistance and recreational fishermen is about 50-100.

2. Basis for the crayfish fisheries

2.1. Crayfish catching is not free.

2.2. The owner of the water area can catch crayfish.

2.3. Catching areas can be hired.

3. Fishing methods and equipment

3.1. Traps and balances, baits: fish or liver.

3.2. Mostly used trap is the Swedish "Trappy".

4. Since when has the species been exploited ?

Pacifastacus leniusculus has been exploited since about 1975, **Astacus astacus** all long.

5. Fishing season

5.1. Crayfish are catched during warm summer months. A peak of season is in August and September.

6. Fishing operations and results

6.1. Catches per fishing effort are depending on the density of the population and may go up to 20 or 30 individuals per trap ("Trappy"),

6.2. With a few single exceptions the degree of exploitation is light.

6.3. There are no statistics available.

6.4. The total annual catch in Austria is about 2 000-5 000 kg. (a personal estimation).

7. Changes in catches and the reason for the changes during the last ten years and/or earlier

There are no significant changes during the last 10 years, exclusing the growing interest in promotion of the authochthonous species.

IV VALUE OF CATCHES AND PROCESSING

1. Value of catches is about 2 Mill. öS.

2. Most fishermens own use.

3. No foreign trade.

V PROTECTION AND MANAGEMENT

1. Regulatory measures

1.1. No limitation of fishing units or total catches.

1.2. Regional different legislative regulations of fishing season, size and sex of Astacus astacus. No legislative regulations for Pacifastacus leniusculus.

2. Control or alteration of the environment

2.1.-2.4. Most crayfish live in natural waters or dredged lakes, sometimes fishermen try to increase production especially with feeding, increasing hiding possibilities, decreasing predators, fertilization, population manipulation, etc.

VI CRAYFISH CULTURE

1. The purpose of crayfish cultivation

The purpose is to produce stocking material amd crayfish for consumption.

2. Methods

2.1. Foods: waist products, potatoes, fish, etc.; handfeeding.
Pellets and other dry foods as bruised grain: feeding with an automatic feeding machine energized with solar energie, feeding during the night.

2.2. Stocking material of Pacifastacus is produced in a privat establishment in Liezen/Styria. Crayfish for consumption are produced in natural waters, carp ponds, dredged lakes and crayfish ponds.

3. Intensity

There are two little establisments producing a few thousands Astacus astacus juveniles (stocking material) per year.
The one producer of Pacifastacus leniusculus stocking material stopped production a few years ago.

VII PARASITES AND DISEASES

Maybe because of the low frequency of crayfish populations there are no great problems with parasites and diseases. One important Astacus astacus population had been destroyed 1987 by crayfish plague, but the fungus was not exactly diagnosed.

Astacus leptodactylus in found in eastern Austria,
Orcones limosus in Salzburg
Astacus astacus, Austropotamobius torrentium and **Pacifastacus leniusculus** are present in whole Austria.

3.2. General description of the habitates:
slow flowing brooks and rivers, lakes, ponds and gravel ditches with summer temperatures of about 15-25 °C.

3.3. Further determinants of distribution are hiding places, low pollution and a restrictive management of predatory fish species (eel). Exploitation is generally no limiting factor.

3.4. The great changes in distribution happened at the end of the last century, caused by **Aphanomyces astaci**. The frequency of the authochthonous species **Astacus astacus** and **Austropotamobius torrentium** declined from about 80 % of waters to the dimension of 0-25 % of waters.

3.5. Current frequency of crayfish populations is 0-25 % for all species.

3.6. Hybridization is not observed.

BELGIUM

P. Gerard

I SPECIES, ORIGIN, GEOGRAPHICAL DISTRIBUTION

1.-2. Nomenclature and origin of the species (Table 1)

Table 1. Scientific and common names of the species. Origin of the species and if introduced the main purpose. (Number refers to the questionnaire. For complete questions, see the questionnaire.)

1.1. Scientific name(s)	1.2. Common name(s)/ in English	2. Origin of the species
Astacus astacus		Native
Astacus leptodactylus	Écrevisses de Turquie/ Écrevisses á pattes gréles	Introduced from unknown place in 1960s.
Orconectes limosus		Natural invasion from France and/or Germany about 1960.
Pacifastacus leniusculus	Écrevisse de Californie/ Californian crayfish	Introduced from USA and Sweden 1979.

3. Distribution

Orconectes limosus: Mainly in waterways.
Pacifastacus leniusculus: In controlled ponds.
The populations of O. limosus and P. leniusculus are self reproducing.

FURTHER INFORMATION

Catch of **Astacus astacus** in public waters is prohibited by the law from 1987 until 1992. This concerns the southern part of the country (Region Wallone). Catch in the northern part of the country is practically non-existent as is the catch of other species in the whole country too.

Crayfish are not produced or imported for stockings.

During the years 1980-1983 the import of crayfish for consumption was about 200 tons per year (30 millions B.F.). More than 95 % were imported alive from Turkey and were **Astacus leptodactylus**. About 35 tons of the total import were further exported to France and the Netherlands.

With the recent drastic reduction of the Turkish supply, import from USA (**Pacifastacus leniusculus** and **Procambarus clarkii**) is expected to increase in the next years.

BULGARIA

R. Avramova

I SPECIES, ORIGIN, GEOGRAPHICAL DISTRIBUTION

1.-2. Nomenclature and origin of the species (Table 1)

Table 1. Scientific and common names of the species. Origin of the species and if introduced the main purpose. (Number refers to the questionnaire. For complete questions, see the questionnaire.)

1.1. Scientific name(s)	1.2. Common name(s)/ in English	2. Origin of the species
Astacus astacus		Native
Astacus leptodactylus	Eschscholtz	Native

3. Distribution (Table 2)

Table 2. Distribution of the crayfish species in Bulgaria.

Species	3.1. Geographical distribution
Astacus astacus	In fast flowing rivers and in lakes in mountain areas
Astacus leptodactylus	In slow flowing rivers, in lakes and barrages in plains and in the Black Sea lakes too

II-IIIPOPULATION AND EXPLOITATION

Freshwater crayfish stocks are not enough studied yet. The available quantity is small. The only crayfish water until 1984 was the lake "Mandra". As a result of water blooming the mortality was high.

Crayfish catching is not commercial. Before year 1984 there was some catching in the lake Mandra, the annual catch being 50 000 - 100 000 crayfish. A special trawl was used in crayfish catching. After water blooming in 1984 catching stopped.

VI CRAYFISH CULTURE

Experiments for cultivating **Astacus leptodactylus** up to market size were carried out in 1980-1983. A new simplified method was introduced to get **Astacus leptodactylus** seed. Experimental work was stopped for two years but will be renewed in order to develope techniques for producing market size crayfish using intensive and semi-intensive methods.

VII PARASITES AND DISEASES

No diseases have been ever observed.

CZECHOSLOVAKIA

J. Rosa

Due to pollution of rivers in Czechoslovakia the number of crayfish dropped so far that crayfish is preserved and at the present measures are taken to increase their numbers.

This condition has occurred during the last 5-7 years; up to that time we exported crayfish out of the country.

At present crayfish are not caught in the country.

CYPRUS

D. Stephanou

I SPECIES, ORIGIN, GEOGRAPHICAL DISTRIBUTION

1.-2. Nomenclature and origin of the species (Table 1)

Table 1. Scientific and common names of the species. Their origin and if introduced the main purpose. (Number refers to questionnaire. For complete questions, see the questionnaire).

1.1. Scientific name(s)	1.2. Common name(s)/ in English	1.3. Origin of the species
Astacus astacus	Astakos tou glikou nerou/ Freshwater lobster	From Denmark in 1976 and 1978 for aquaculture and for the stocking of inland waters
Pasifastacus leniusculus	Astakos tou glikou nerou/ Freshwater lobster	From Sweden in 1979 for aquaculture and for the stocking of inland waters
Procambarus clarkii	Astakos tou glikou nerou/ Freshwater lobster	From Singapore in 1983 for ornamental purpose (aquaria) and stocking of inland waters

3. Distribution

3.1. A. astacus is found at Lefkara reservoir and P. leniusculus in Xerarkaka small reservoir. The latter is also found at Phini Fisheries Ltd., trout farm, at Phini village. P. clarkii has established a thriving population in Athalassa reservoir and is found in irrigation and garden ponds in the lowlands.

3.2. General description of the habitats were the crayfishes live (Table 2).

Table 2. The quality of water, bottom and river bed at the three dams where the two crayfish species live.

Species	Quality of water	Bottom of reservoirs
Astacus astacus	pH 8 hardness 200-250 ppm ($CaCo_3$)	Mud mixed with sand, gravel, sand
Pacifastacus leniusculus	pH 8 hardness 220 ppm ($CaCo_3$)	Mud, sand
Procambarus clarkii	pH 8.5-9 hardness 340 ppm ($CaCO_3$)	Mud, sand

II POPULATION

Astacus astacus culture is abandoned. **Pacifastacus leniusculus** is under experimental culture at the private commercial trout farm of Phini Fisheries Ltd., while **Procambarus clarkii** has established self-substained populations at several water bodies.

III EXPLOITATION

-

IV VALUE OF CATCHES AND PROCESSING

-

V PROTECTION AND MANAGEMENT

Procambarus clarkii was fished by anglers at Athalassa reservoir until 1988 when angling was prohibited due to pollution problems.

VI CRAYFISH CULTURE

1. The purpose of crayfish cultivation by the commercial trout farm is to establish methods of culture which will allow their commercial exploitation. As refers to government efforts the culture and stocking of Astacus astacus was abandoned due to the unfavourable results given. The hatchery work for the production of young P.leniusculus for the stocking of inland water bodies also stopped because of problems encountered with the loss of eggs by the berried females.

2. Methods

2.1. Food consists of trout pellets, potatoes, carrots and leaves of Alnus orientalis. Food is provided once or twice a day, depending on the age of the crayfish and the season.

2.2. The crayfishes are cultivated in cement ponds, of raceway type, which contain bricks and pieces of pipes. The berried females are kept in hatchery trays and tanks.

3. Intensity

3.1. At Phini trout farm there exist a total of about 200 crayfish out of which about 150 are adults.

3.2. The number of cultivation units: 2 cement ponds, several hatchery trays and tanks.

3.3. The capacity of the ponds is about 30 tons and that of the tanks is 0.5 ton each.

VII PARASITES AND DISEASES

Helminths

When Astacus astacus was imported it was found heavily infected with Branchiobdella sp.

The most effective and practical treatment proved to be NaCl bath (NaCl 2,5 % for 15 minutes). The parasite was eradicated after some treatments.

A. astacus and **P. leniusculus**, when kept in captivity for culture, have some times minor symptons indicating the presence of the "maladie des taches". No special treatment has been tried, but improvement of the cultivation conditions gave positive results.

It was also noted erosion in sites of lost appendages, especially of antennae, following copulation and/or loss of condition. Treatment with malachite green 0.1 ppm for 1 hour gave positive results. That was not a significant problem. No disease problems were encountered with the **P. clarkii**.

DENMARK

V. Hørlyck, G. Rasmussen

I SPECIES, ORIGIN, GEOGRAPHICAL DISTRIBUTION

1.-2. Nomenclature and origin of the species

Table 1. Scientific and common names of the species and the origin of the species. (Number refers to the questionnaire. For complete questions, see the questionnaire).

1.1 Scientific name(s)	1.2 Common name(s)/ in English	2. Origin of the species
Astacus astacus	Flodkrebs/ Crayfish	Native
Pacifastacus leniusculus	Signalkrebs	Non-native
Potamobius leptodactylus	Galizisk sumpkrebs	Non-native

3. Distribution (Table 2)

Table 2. Distribution of the crayfish species in Denmark.

Species	3.1 Geographical distribution	3.2 Description of the habitats	3.3 Determinants of distribution	3.4 Changes in distribution areas	3.5 Frequence in the distribution area (% of waters)	3.6 Hybridi-zation
Astacus astacus	All over the country	Rivers, lakes, glacial lakes and flowing waters	Pollution	-	50 - 75 %	-
Pacifastacus leniusculus	Sealand	Small lakes	Stockings are illegal	-	0 - 25 %	-
Potamobius leptodactylus	Sealand	Small lakes	Stocking are illegal	-	0 - 25 %	-

II POPULATION

1.1. On localties where the crayfish **A. astacus** is found it is abundant.

1.2. In bigger lakes it is fairly scarce.
In small lakes and ponds the population is dense.

1.3.-1.4. In many small ponds the density has increased because of restoration of the habitant and because of stockings.

III EXPLOITATION

1. Fishermen

1.2. About 10 persons.

1.3. Nearly only recreational fishermen.

2. Basis for the crayfish fisheries

2.1 No.

2.2 The owner of the water area can catch crayfish.

2.3 Yes.

2.4. No.

3. Fishing methods and equipment

3.1 Only traps are used.

4. The species has been exploited from ancient times.

5. Fishing seasons

5.1 Fishing season is open: females 1.8. - 30.9.
males 1.4. - 30.9.

6. Fishing operations and results

6.2. Moderate.

6.3. Not known.

6.4. Not known.

IV VALUE OF CATCHES AND PROCESSING

1. Value of catches

Not known.

2. Use of fishing areas

Fishermen's own use.

3. Foreign trade

No export, import is increasing but the present amount is unknown.

V PROTECTION AND MANAGEMENT

1. Regulatory measures

1.1. Legal size is 9.0 cm.

1.2. Closed season: females 1.10. - 31.7.
males 1.10. - 31.7.

VI CRAYFISH CULTURE

1. The purpose of crayfish cultivation

To provide stocking materials.

2. Methods

2.1. With and without feeding.

2.2. Recirculated systems (intensive) and ponds (expensive).

3. Intensity

Production in 1989 app. 1 000 kg. At the moment 41 members of the crayfish association.

VII PARASITES AND DISEASES

Table 3. The parasites and diseases which have been found in the crayfish, **Astacus astacus**, in Denmark.

Virus diseases	Bacterial diseases	Fungal diseases	Protozoan	Helminths	Others
?	?	Ramularia	Thelohania contejeani	Branchiobdella	Trematoda
		Achlya prolifera			

FINLAND
K. Westman, M. Pursiainen, T. Järvenpää, V. Nylund

I SPECIES, ORIGIN, GEOGRAPHICAL DISTRIBUTION

1.-2. Nomenclature and origin of the species (Table 1)

Table 1. Scientific and common names of the species. Origin of the species and if introduced the main purpose. (Number refers to the questionnaire. For complete questions, see the questionnaire).

1.1. Scientific name(s)	1.2. Common name(s)/ in English	2. Origin of the species
Astacus astacus	Rapu, jokirapu/ Crayfish	Native
Pacifastacus leniusculus	Täplärapu/ Signal crayfish	First introduced from the USA in 1967, for stocking experiments. Further introductions with juveniles imported from Sweden in 1971-1974
Astacus leptodactylus	Kapeasaksirapu	First report of the species in 1977

3. Distribution (Table 2)

Table 2. Distribution of crayfish species in Finland

Species	3.1 Geographical distribution	3.2 Description of the habitats	3.3 Determinants of distribution	3.4 Changes in distribution areas	3.5 Frequency in the distribution area (% of waters)	3.6 Hybridization
Astacus astacus	Up to 66°N in the Western part of the country. Only seven of the 74 major watercourses flowing north have no crayfish	Rivers, lakes and brooks	The northern limit depends on temperature, pollution, water course construction, crayfish plague	No dramatic changes in the last 10 years. Crayfish plague disasterous in the beginning of the century	50 - 75 %	Not observed
Pacifastacus leniusculus	In a few, mostly small lakes in Southern and Central Finland (test implantations)	Small and medium sized lakes	Test stockings only made in about 100 small lakes, most of them isolated			Not observed
Astacus leptodactylus	Only one case in Southeast Finland	A small river flowing to the Soviet Union				

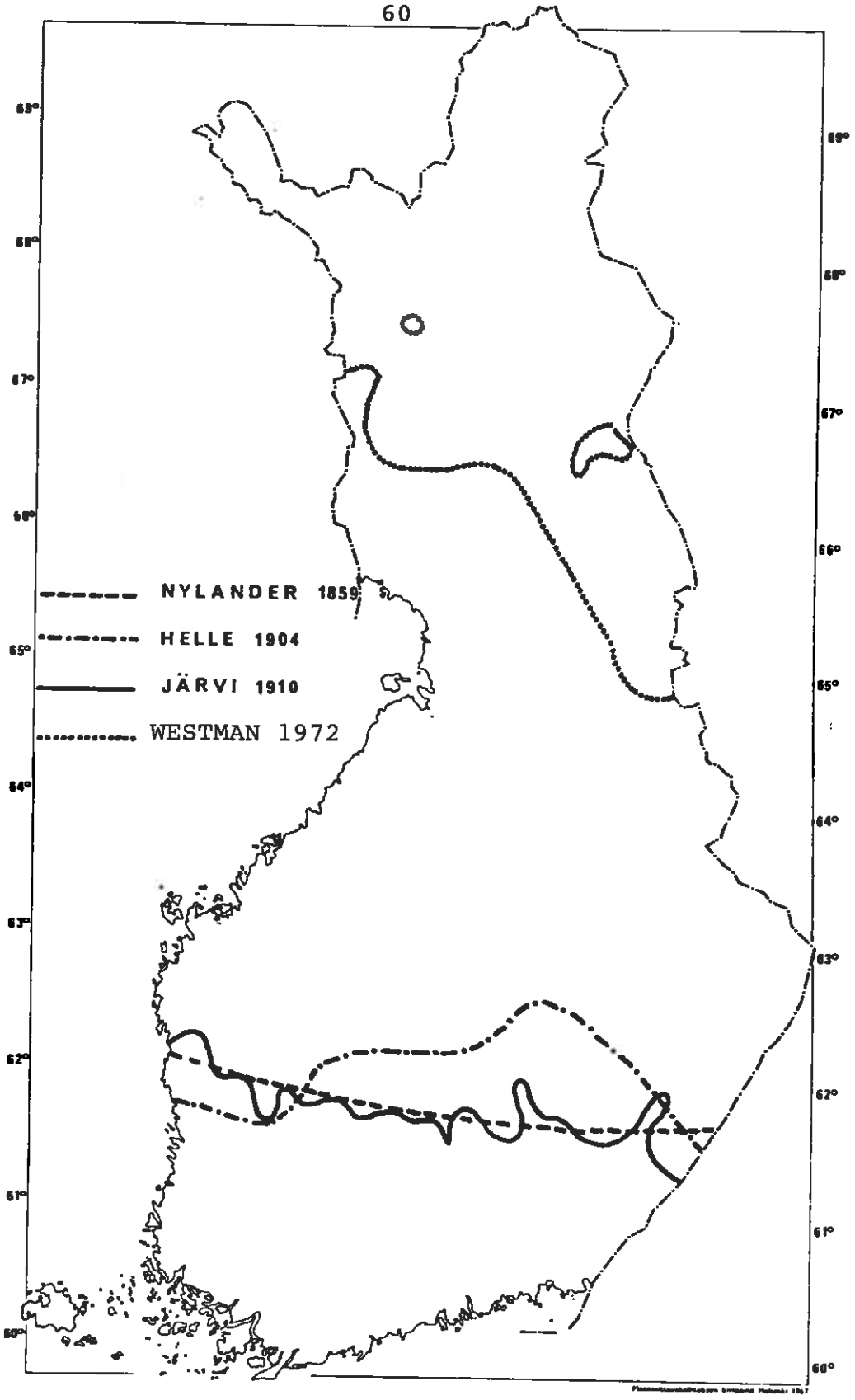


FIGURE 1. The natural distribution of Astacus astacus in Finland (drawn from data of Nylander 1859, and Helle 1904, and redrawn from Järvi 1910) and the distribution in 1972 (Westman 1973).

II POPULATION

1. Abundance and density of the population (Table 3)

Table 3. Abundance and density of the crayfish population in Finland

Species	1.1 Average abundance in the distribution area	1.2 Population size and density in different habitats	1.3 Changes in abundance	1.4 Reasons for the changes
Astacus astacus	Rather sparse on average. Abundant in a number of waters and even dense populations	Scarce in great lakes. In some small lakes 2-5 ind. m^2, in some rivers as much as 12 ind. m^2	Decreased in most waters, fluctuation in population size	Crayfish plague and deterioration of the environmental conditions

III EXPLOITATION

1. Fishermen

Table 4. Number of fishermen

1.1 Professional fishermen	1.2 Semi-professional fishermen	1.3 Subsistence and recreational fishermen
0	1 000 - 5 000	100 000

2. Basis for the crayfish fisheries

2.1. Catching is not allowed freely.

2.2. The owner of the water area is allowed to make catches.

2.3. Catching areas may be hired.

3. Fishing methods and equipment

3.1. The most important equipment is various traps and balances. Angling with baits and manual picking are also used. Fish (roach and other cyprinids) is usually used as bait.

3.2. Different kinds of equipment are used in different parts of the country.

4. Since when has the species been exploited?

Astacus astacus has been exploited for many centuries (from at least the 16th century).

Pacifastacus leniusculus is exploited in a few waterbodies.

5. Fishing seasons

5.1. 21 July - 31 October
The fishing peak occurs during the first two to three weeks of the season.

6. Fishing operations and results

6.1. Catches may vary from 0 to several tens of individuals per trap.

6.2. The exploitation can be considered heavy in most good crayfish waters.

6.3. Catch statistic are available for 1984, 1986 and 1988. Foreign trade statistic are available until 1987.

6.4. According to the questionnaire surveys made in 1986 and 1988, about 3.5 million individuals.

7. Changes in catches and the reasons for the changes during the last ten years and/or earlier

No dramatic changes during the last ten years.
In the beginning of the century, the catch declined sharply from a maximum of about 20 million specimens

in 1900 to a few million specimens. The drop was caused by the crayfish plague.

IV VALUE OF CATCHES AND PROCESSING

Table 5. Value, use and foreign trade of the crayfish catches in Finland.

Species	1. Value of catches	2. Use of catch fishermen's own use	for sale	3. Foreign trade import	export	trend
Astacus astacus	30-35 million FIM/year[1)]	Large proportion of the catch	On the domestic market	[2)]	Very important earlier Now sporadic.	Export decreased from 16 million specimens at most around 1900 to about 100 000 specimens during the late 1970s
Astacus leptodactylus Pacifastacus leniusculus Procambarus clarkii	-	-	-	Began in 1969; after 1971 exceeded export of Astacus astacus. Import of A. leptodactylus began in 1969, and import of the American crayfish species in 1984. On average 1-3 million specimens/ [2)]year.(1 120 000 in 1987)		

[1)] rough estimate (based on catches of 3.5 million specimens/ year)

[2)] a small proportion of import consists of the species A. astacus

Crayfish are imported deep-frozen

There is no processing industry in Finland (except for one cooking-plant).

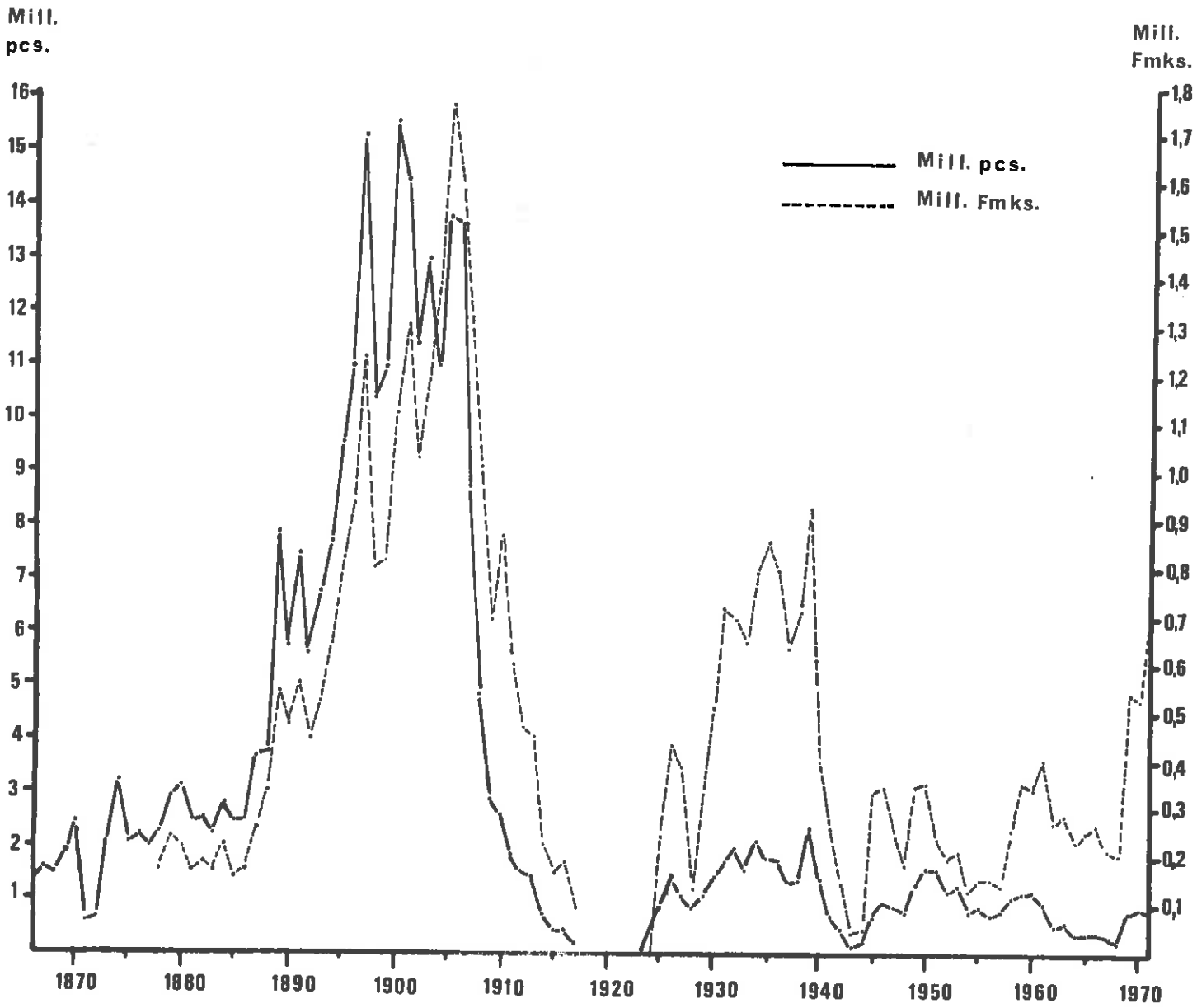


FIGURE 2.

The export of Astacus astacus from Finland during 1866-1971 and its commercial value expressed in terms of the monetary rate in 1971 (Westman 1973).

V PROTECTION AND MANAGEMENT

1. Regulatory measures

1.1. **Astacus astacus:**
Fishing allowed from 21 July to 31 October; the permission of the owner of the fishing area is required.
From the beginning of 1983, a state fishing licence has also been needed.

1.2. **Astacus astacus:**
Size limitation: Only individuals $\geqq$ 10 cm may be caught.
Seasonal protection from 1 November to 21 July.

2. Control of alteration of the environment

2.1. - 2.2. Physical and chemical features.
No control from the point of view of crayfish fisheries.

2.3. Biological features
Disease control, in accordance with the needs stated by the water owner, is undertaken by the State Veterinary Medical Institute.

Import of living crayfish is allowed only with a permit from the Ministry of Agriculture and Forestry.

2.4. Stocking
Astacus astacus:
Sporadic transplantations of adult individuals and one-summer-old young by water owners.

Some transplantations by the Finnish Game and Fisheries Research Institute, for investigation purposes.

Pacifastacus leniusculus:
Introduced for investigation purposes by the Finnish Game and Fisheries Research Institute. Between 1967 and 1974, a total of about 40 000 signal crayfish were stocked in 52 small lakes, preferably those with no inlets or outlets. The majority, some 35 500, were newly-hatched juveniles imported from Sweden: the rest were cultivated, larger

juveniles and adults. Adult signal crayfish were imported from the USA.

In 1981 stockings were started again with one-summer-old juveniles produced in domestic farms. The total number of stocked individuals in 1989 came to about 20 000.

VI CRAYFISH CULTURE

1. The purpose of crayfish cultivation

Astacus astacus and Pacifastacus leniusculus:
There are a few commercial crayfish farms in Finland. The purpose of cultivation has thus far been to produce stocking material.

Lot of experiments to cultivate brood crayfish as well as juveniles have been done. The juveniles are produced by both "natural hatching" and artificial incubation of eggs.

2. Methods

2.1. Cultivation studies have been carried out both with natural and artificial food in ponds and basins.

3. Intensity

3.1. For the present a few hundred thousand crayfish juveniles are produced per year.

3.2. 30-35 farms are cultivating **Astacus astacus.**
15-20 farms are cultivating **Pacifastacus leniusculus.**

3.3. The farms are small but they are increasing their production.

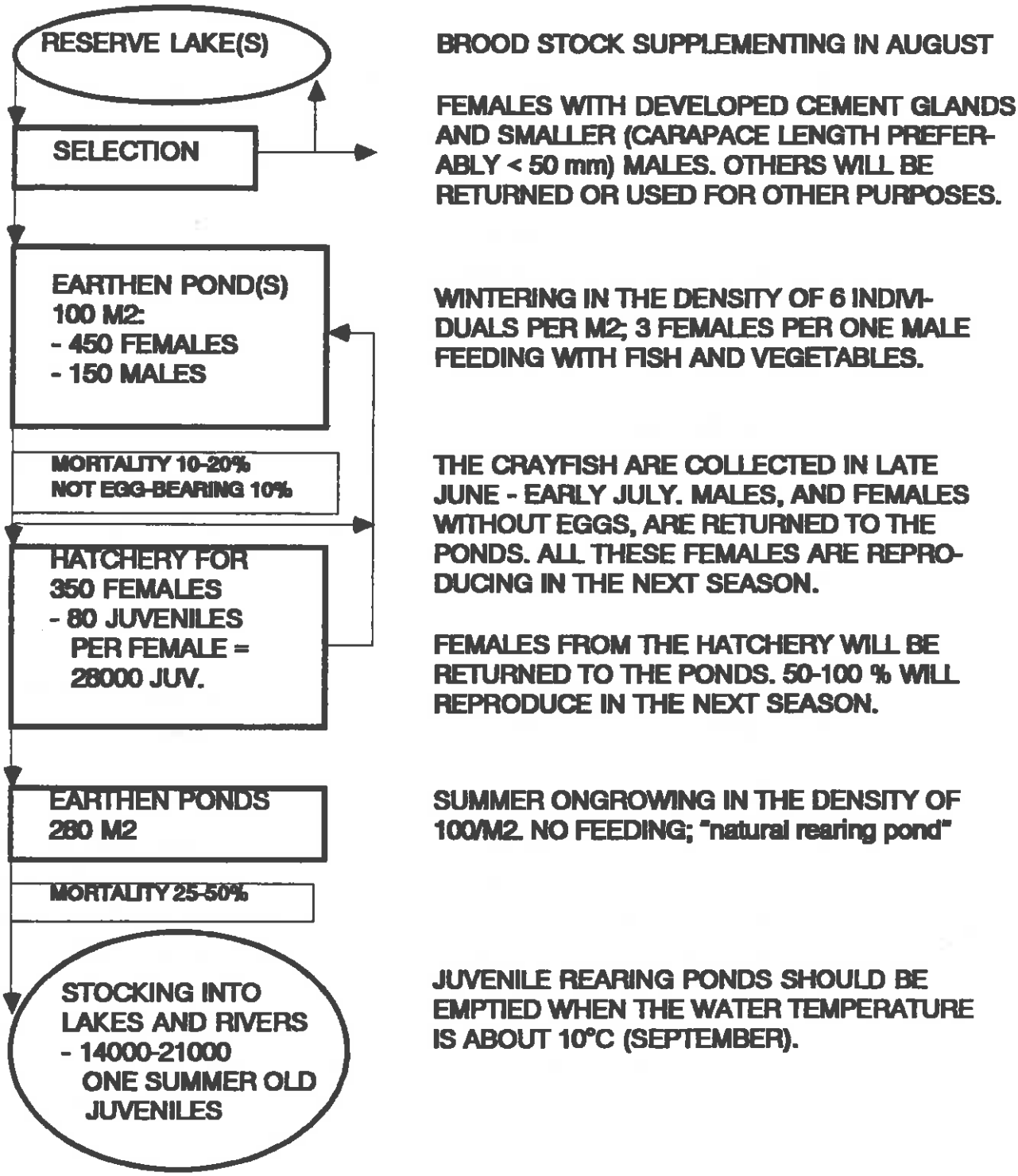


Figure 3. A model of the noble crayfish Astacus astacus culture at Evo Inland Fisheries and Aquaculture Research Station

VII PARASITES AND DISEASES

Virus diseases

No virus studies have been carried out on crayfish in Finland.

Bacterial diseases

No bacterial diseases affecting crayfish have been noted in natural waters in Finland, nor have there been any studies to investigate their existence.

In a culture experiment carried out in 1971 with young signal crayfish, an **Aeromonas hydrophila** infection was found which caused the death of crayfish in the high-density cultivation groups.

Fungal diseases

Crayfish plague (**Aphanomyces astaci**)

1. Crayfish species

   Astacus astacus

2. Origin of the disease

   Crayfish plague spread to Finland from Russia in 1893, presumably as a result of the crayfish trade.

3. Distribution

   A good deal is known about the spread of crayfish plague in Finland. A list has been compiled from the literature on mortality among crayfish caused, or thought to have been caused, by crayfish plague in the years 1893 - 1988.

   The plague was first observed in Lake Saimaa and in some snaller lakes close by. The fungus spread, at first very slowly, in the crayfish waters, and it seemed possible to restrict the disease to areas already infected. However, in 1907 the plague burst out in the Kokemäenjoki watercourse, which had previously been the best crayfish water.

   After decimating crayfish populations in the Kokemäenjoki watercourse, the plague spread further, to nearby river systems.

Some 200 plague observations had been made up to 1930, and 12 of the total of 74 major watercourses had been infected.

In the 1930's and 1940's, 132 new plague observations were made, and nine watercourses were infected. These proved, however, to be exceptionally "good" years, as the situation got considerably worse in the fifties, when about 185 new plague observations were made. The situation was, if possible, even worse in the good crayfish rivers flowing to the Gulf of Bothnia where crayfish populations were devastated.

Along with the plague, increasing manipulation of water resources has contributed to the disappearance of the crayfish.

Of the 74 major watercourses in Finland, excluding the seven flowing North and in which crayfish have never lived, only 20 remain uninfected.

Following the decimation of crayfish populations due to crayfish plague and river construction work, the plague has become restricted to just a few areas. Today, crayfish plague occurs in different parts of the country in 3-5 major waterway systems, where it gradually spreads each year to new areas. In addition, a number of outbreaks of crayfish plague are reported each year in small waters, where the plague rapidly destroys the entire crayfish population.

4. Significance

4.1. All infected crayfish die within a few weeks irrespective of the temperature of the water. So far, no crayfish populations or individual crayfish that are resistant to the plague have been found.

4.2. Crayfish plague usually destroys the entire crayfish population of the water despite any obstacles restricting its natural spread. In some cases, the crayfish populations in the upper reaches or small tributaries of rivers may escape infection. Crayfish plague is often spread to

different parts of the watercourse or to other waters by man, occurring with the transfer of crayfish traps or with the crayfish themselves.

Changes in the significance of crayfish exported reflect the significance of crayfish plague for crayfish populations. The fall in the number of crayfish exported from the record figure of 15.5 million in 1900 to 1-2 million per year in the period 1930-1940 is thought to have been largely the result of crayfish plague. In the last few years, imports of crayfish have exceeded exports (see IV, Table 5).

4.3. In 1978-1980 and in 1989 an outbreak of crayfish plague in three different culture experiments destroyed all crayfish. No definite explanation has been found as to how the plague spread to the experimental stations.

5. Preventive measures and treatment

5.1. The legislation on fishing empowers the Ministry of Agriculture and Forestry to impose bans of restrictions on the transport, storage and sale of crayfish, their import and export, and on the transfer of the equipment used to catch, store and tansport crayfish from one place to another.

The Ministry of Agriculture and Forestry has ruled that crayfish may only be kept in receptacles containing the water from which they were caught, and that these may not be moved from the water or even to another part of the same water. However, it is permitted for a live crayfish caught in different waters and being offered for sale to be washed or otherwise treated in a water that does not hold crayfish and from which there is no likelihood of any crayfish disease spreading to any other water, provided permission is first obtained from the owner of the fishery.

Dead and diseased crayfish must be destroyed, either by burning or boiling, in order to prevent the spread of crayfish plague.

Only crayfish that can be proved to have been caught in waters free from plague may be used for stocking purposes. Until 1970, the legislation on fishing required that, throughout Finland, crayfish traps be kept in boiling water for at least ten minutes before the start of fishing each year. The same applies before the traps can be transferred from one water to another or to another part of the same water. The present practice favours the use of disinfection of fishing gear, e.g. using 4 % formalin every time the gear is transferred from one water to another or to another part of the same water, irrespective of whether or not crayfish plague has been found in the water.

5.2. No chemical agents have been used in Finland to control crayfish plague.

5.3. Electric barriers have not been tried in Finland. The most important factor in controlling crayfish plague is to prevent the spread of the plague to other waters. It is often in the interests of control if the plague destroys the entire crayfish population of a particular water as rapidly as possible, since the plague itself then disappears. The risk of the plague spreading to other waters thus diminishes, and these areas can soon be re-stocked with crayfish.

In order to reduce the damage caused by crayfish plague, research and experimental work has been carried out in Finland since 1967, to determine the viability of the plague-resistant signal crayfish in waters affected by crayfish plague.

1. Crayfish species

Pacifastacus leniusculus

2. Origin of the disease

In 1967-69 adult signal crayfish were introduced into Finland from Lake Tahoe (USA) for trial stocking, carried out in eight small lakes (see I, Table 1). The crayfish were subsequently found to have dark brown spots, indicating infection with crayfish plague. Populations developed

from juveniles imported from Sweden have had no brown spots on the crayfish.

3. Distribution

Adult signal crayfish were introduced into eight experimental lakes situated in Southern and Central Finland. In 1971-72 young signal crayfish imported from Sweden were introduced to several experimental lakes. Self-reproductive signal crayfish populations which have developed from adult crayfish now occur in three experimental lakes. The occurrence of crayfish plague has been observed in two of the signal crayfish populations that have been studied.

4. Significance

The occurence of the brown spots indicative of crayfish plague was investigated in 1979-1988 in three lakes inhabited by self-propagating populations of the American crayfish. The crayfish examined came from catches made with crayfish traps. In one lake, in which the crayfish population had developed from juveniles imported from Sweden in 1971, the crayfish examined showed no brown spots at all. The lake also contains a population of the native crayfish (**Astacus astacus**), which indicate the absence of crayfish plague. In two of the lakes the crayfish populations originated from adults imported from Lake Tahoe, USA, in 1969. The frequency of infected crayfish in the lakes (totally 1175 examined) was high - 47 % and 52 % in 1979 but it decreased annually and in 1988 only 11.8 % and 10.5 % of the crayfish were infected. However, there was no appreciable change in the catch effort and handling of the crayfish. The brown spots most commonly occurred on the walking legs (38 % and 40 % of spots), and the chelae (30 % and 28 %). The average number of spots per crayfish was 2.3 and 2.0.

Crayfish plague has not been found to cause any harm to the signal crayfish populations in the experimental lakes.

Burned spot disease (Ramularis astaci)

1. Crayfish species

Astacus astacus

2. Origin of the disease

No information is available on the origin of the disease, or on when or how it spread. The disease was first encountered in Finland in 1977.

3. Distribution

So far the disease has only been confirmed in one lake in Southern Finland.

4. Significance

The frequency of occurrence of the disease in the lake's crayfish population has not been studied. So far only one infected crayfish has been observed.

5. Preventive measures and treatment

The only known way of preventing the disease is to destroy the infected crayfish.

Protozoan diseases

White tail disease (**Thelohania contejani**)

1. Crayfish species

Astacus astacus

2. Origin of the disease

White tail disease was first found in Finland in 1965. The fact that infected individuals were observed over a wide area in different parts of the country suggests that the disease has occurred in Finland for a long time. Nothing is known of the origin of the disease, or when or how it spread.

3. Distribution

3.1. With the exception of Southeast Finland, white tail disease has been found so far in most of the range of the crayfish.

3.2. By 1982 the disease had been found to occur in 30 crayfish waters. One or two new locations are reported every year.

3.3. There are still continuous reports that the disease is

being found in new locations. Observations of the disease are made difficult by the fact that, in the cases studied, the proportion of infected crayfish in the catch has been extremely low compared to the frequency of infection reported in Central Europe. It is likely that not all sites of occcurrence are known yet.

4. Significance

4.1. In the cases studied, the tail muscles of infected crayfish caught in traps were found to contain large numbers of spores. The disease is apparently of very long duration, since the infected crayfish, when caught survived in an aquarium for a further 4-7 months after capture.

4.2. In most of the cases studied so far in Finland, the proportion of crayfish infected with T. contejeani has been less than two per cent of the crayfish caught in traps, exept in some acidified waters where up to 10 per cent of the crayfish were infected. The reason for low frequency of occurrence is not known with certainty. It may be that the traps widely used in Finland do not catch all the infected individuals, which tend to move around less. Differences in climate, water quality and crayfish population densities may also play a part. Because of the long duration of the disease, most of the infected crayfish may die during the winter when the water is cold and when no observations of crayfish killed by the disease can be made.

4.3. Experiments carried out under cultivation conditions thus far have not shown that the disease spreads to other crayfish. The reason for this is, presumably, the short duration of the experiment. It seems that contracting the disease requires that the infected crayfish be eaten, after which it may take several months for visible symptoms to appear and even more than one year before the infected crayfish dies. Under certain cultivation conditions, however, the disease may cause widespread epidemics among crayfish. Infection carried by, but not apparent in, crayfish used for stocking may cause the disease to spread to natural waters.

5. Preventive measures and treatment

The only way to prevent the spread of the disease known at present is to remove all crayfish suspected of being infected from the water and to destroy them.

Psorospermium haeckeli

1. Crayfish species

Astacus astacus

2. Origin of the disease

Psorospermium haeckeli was first found in Finland in 1975. Nothing is known of the origin of the disease, or when or how it spread. Observation is difficult because the parasite does not give rise to visible external symptoms in the crayfish.

3. Distribution

Psorospermium parasites have so far been found in over 30 lakes in Southern amd Central Finland. The distribution of the disease yet to be studied systematically.

4. Significance

4.1. Varying numbers of the parasite's sporelike phase are found in most tissues of infected crayfish. In one study, the parasite was found in extremely large numbers, some 50-60/mm^2, on the innerside of the carapace. Smaller numbers of parasites were found in the eyes, gills, tail muscles, etc. The parasites are often surrounded by large numbers of haemolymph leucocytes, and sometimes by melanin. Local damage to the carapace of infected crayfish induced experimentally led to the formation of large holes and eventually to the death of the crayfish. This may be important to crayfish mortality, as crayfish sustain shell damage, e.g. during fights with other crayfish.

4.2. The frequency of occurrence of the parasite in the several of the infected crayfish populations studied has been 100%.

4.3. Experiments carried out under culture conditions so far

have failed to show that the parasite is transmitted to other crayfish. Under certain conditions, the parasite may be important in crayfish culture, contributing to the death of crayfish with shell damage.

5. Preventive measures and treatment

The taxonomic position, life cycle, etc. of the **Psorospermius** parasite have not yet been established, and thus nothing is known about how the infection is transmitted. The fact that the disease seldom gives rise to visible external symptoms makes it difficult to pick out and destroy infected crayfish.

Helminths

Branchiobdella pentodonta

1. Crayfish species

Astacus astacus

2. Oridin of the disease

B. pentodonta was first found in Finland in 1889.

3. Distribution

B. pentodonta has been found so far in crayfish in numbers of lakes in Southern part at Finland. No comprehensive study of the occurrence of **Branchiobdellidae** has been carried out.

4. Significance

In some of the cases studied, up to several thousand **Branchiobdellidae** have been found on the shell of a single crayfish, and they were not found to harm the crayfish.

Xironogiton instabilius and Cambarincola sp.

1. Crayfish species

Pacifastacus leniusculus

2. Origin of the disease

A number of individuals and egg cocoons of the species **Xironogiton** and **Cambarincola** were found on the shells of signal crayfish imported from Lake Tahoe, USA in 1968-69.

3. Distribution

Trial stocking with signal crayfish has been carried out in some 100 waters in Southern and Central Finland.

4. Significance

Individuals and eggs cocoons of the species **Xironogiton** were found on 5 % of a batch of imported signal crayfish. The occurrence of the species among the signal crayfish populations in the experimental lakes has not been studied.

Nematoda sp.

The occurrence of nematodes and other parasitic worms in crayfish has not been studied in Finland.

Tumours

There are no reports of crayfish tumours in Finland.

FRANCE

P. J. Laurent

I SPECIES, ORIGIN, GEOGRAPHICAL DISTRIBUTION

1.-2. Nomenclature and origin of the species (Table 1)

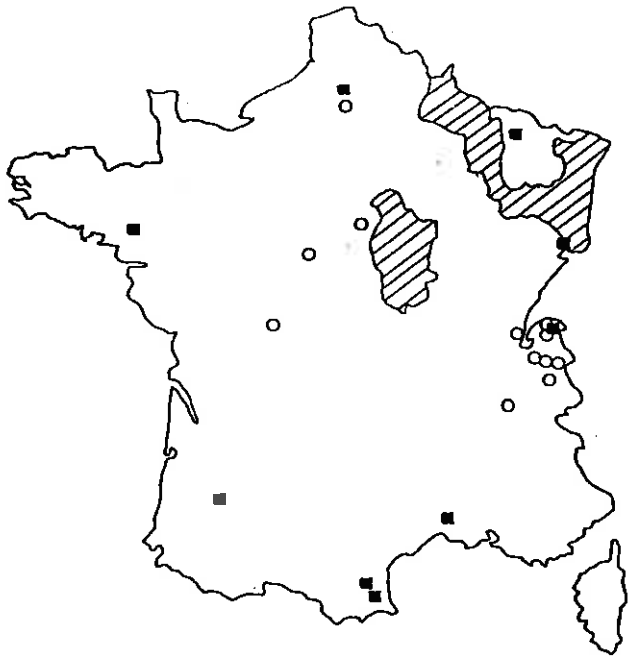
Table 1. Scientific and common names of the species. Origin of the species and if introduced the main purpose. (Number refers to the questionnaire. For complete questions, see the questionnaire.)

1.1. Scientific name(s)	1.2. Common name(s)/ in English	2. Origin of the species
Astacus astacus	Ecrevisse á pieds rouges/ River crayfish	Native
Astacus leptodactylus	Ecrevisse turque/ Turkish crayfish	Introduced from Turkey for crayfish farming experiments
Austropotamobius pallipes	Ecrevisse á pied blanc/ White clawed crayfish	Native on most parts of France
Orconectes limosus	Ecrevisse américaine/ American crayfish	Introduced from Germany to the River Cher at the beginning of this century
Pacifastacus leniusculus	Ecrevisse californienne/ Californian crayfish	Introduced from Sweden and directly from USA

3. Distribution (Table 2)

Table 2. Distribution of the crayfish species in France

Species	3.1 Geographical distribution	3.2 Description of the habitats	3.3 Determinants of distribution	3.4 Changes in distribution areas	3.5 Frequency in the distribution area (% of waters)	3.6 Hybridization
Astacus astacus	In the north-eastern parts of the country	Deep rivers and lakes	Diseases and pollution	Since a century very strong reduction; now quite a relict	Only present on some places	Not observed
Astacus leptodactylus	In some places around the country	Lakes	Temperature	Distribution extending	0-25 %	Not observed
Austropotamobius pallipes	Mainly in the southern part of the country	Some small lakes with springs and low tempereture	Temperature and substrate	Very strong decrease since the beginning of this century	0-25 %	Not observed
Orconectes limosus	Mainly in northern and nortwestern parts of the country	Slow flowing, muddy waters, canals and fish ponds	Very slow flowing waters	Very strong increase due to migration and especially man's propagation	Depends on the place in some areas 100 % of the waters	Not observed
Pacifastacus leniusculus	In some places	Brooks, lakes and gravel pits	Temperature and substrate	Introduced for experimental purpose to some places only, no information on private properties		Not observed



THE DISTRIBUTION OF CRAYFISH SPECIES

IN FRANCE
(1977)

FIGURE 1.

Astacus astacus

Astacus leptodactylus

Pacifastacus leniusculus

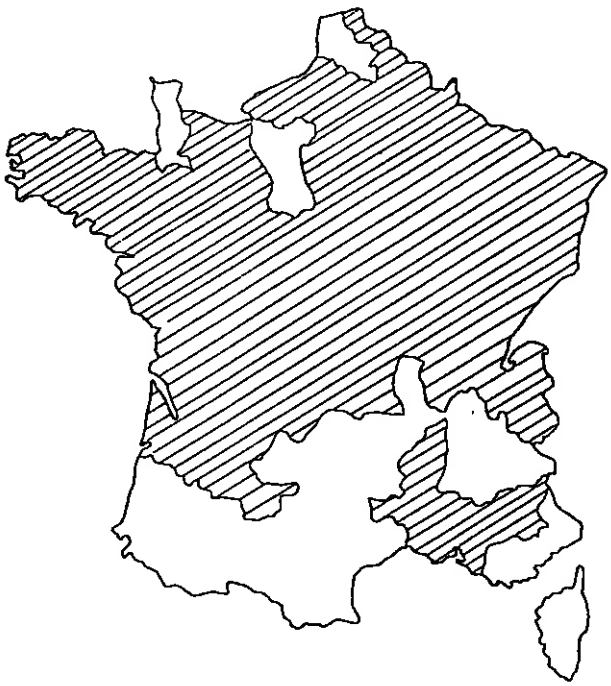


FIGURE 2.

Orconectes limosus

FIGURE 3.

Austropotamobius pallipes

II POPULATION

1. Abundance and density of the crayfish population

Table 3. Abundance and density of the crayfish population in France.

Species	1.1 Average abundance in the distribution area	1.2 Population size and density in different habitats	1.3 Changes in abundance	1.4 Reasons for the changes
Astacus astacus	Very sparse but no precise data	No data	Decreased	Diseases (crayfish plague) water pollution in big rivers
Astacus leptodactylus	No precise data	No data	No data	No data
Austropotamobius pallipes	Sparse	Very few data at hand	Continuously decreasing	Water pollution, diseases, over fishing in some places
Orconectes limosus	Often very abundant. Precise data only from some places	No data	Strongly increased	Man's propagation
Pacifastacus leniusculus	Fairly abundant or abundant in some experimental lakes	Fairly dense or dense	Where acclimatized, increasing	Good survival of the crayfish

III EXPLOITATION

1. Fishermen

Table 4. Number of fishermen

Species	1.1 Professional fishermen	1.2 Semi-professional	1.3 Subsistence and recreational fishermen
Astacus astacus	None	None	Very few but impossible to evaluate (cf. Austropotamobius pallipes)
Astacus leptodactylus	None	None	Recreational fishermen on some reservoirs where it is abundant (southwestern parts of France)
Austropotamobius pallipes	None	Probably none	Impossible to evaluate. Each owner of a fishing licence can catch crayfish. There are between 3 and 4 millions on fishermen (anglers) in France.
Orconectes limosus	Lake Annecy 1981: 10 1984: 7 1985: 5 Lake Bourget 1985: 2	On some big lakes and some large rivers	Impossible to evaluate.
Pacifastacus leniusculus	None	None	On some experimental lakes several hundreds of recreational fishermen

2. Basis for the crayfish fisheries

Table 5. Basis for the crayfish fisheries in France.

Species	2.1 Crayfish catching is free	2.2 The owner of the water area can catch crayfish	2.3 Catching area can be hired	2.4 Other basis
Astacus astacus	No	Yes, in respect with the regulations	Yes, on a private property	
Astacus leptodactylus	No special regulation	Yes, on a private property	Yes, on a private property	
Austropotamobius pallipes	No	Yes, in accordance with regulations	Yes, on a private property	
Orconectes limosus	Yes	Yes, on a private property	Yes, on a private property	Authorities try to wipe it out as much as possible and many illegal fishing methods are tolerated
Pacifastacus leniusculus	No, there are special regulations	Yes, on a private property	- " -	

3. Fishing methods and equipment

3.1. Astacus astacus, Astacus leptodactylus and Austropotamobius pallipes are catched only with balances. Orconectes limosus is picked with hands and catched with traps and balances. Pacifastacus leniusculus is only angled with baits.

3.2. Mesh size is 27 mm. Balances can be circular with a diameter of 30 cm or rectangular or lozengic with a diagonal of 30 cm.

4. Since when has the species been exploited

Astacus astacus and **Austropotamobius pallipes** have been exploited since ancient times.

Astacus leptodactylus has been exploited very soon after acclimatisation.

Orconectes limosus has been exploited since it became abundant after introduction or new migration.

Pacifastacus leniusculus has been exploited in some places for 7-8 years.

5. Fishing seasons

5.1.-5.2. **Astacus astacus**: from August 1st to 15th but there are many limitations and in some places fishing is totally forbidden.
Astacus leptodactylus: There are no closed seasons. The peak is in summer.
Austropotamobius pallipes: Two first weeks in August (like **Astacus astacus**) but in many places crayfish fishing is not allowed in order to protect a "relict".
Orconectes limosus: Fishing season depends on places, but generally it is from 15th of June to 15th of September.

6. and 7. Fishing operations, results and changes in catches and reasons for the changes (Table 6)

Table 6. Catches per unit fishing effort, degree of exploitation, catch statistics, total annual catch and changes in catches and the reasons for the changes in France.

Species	6.1 Catch per unit fishing effort	6.2 Degree of exploitation	6.3 Catch statistics available	6.4 Total annual catch	7. Changes in catches during the last 10 years or earlier and the reasons
Astacus astacus	No data	Unsignificant	No data	No data	Strong reduction for a century ago. Diseases, water pollution
Astacus leptodactylus	No data	No data	No data	No data	No data
Austropotamobius pallipes	No data	No data	No data	No data	Decreased strongly since the beginning of this century. Water pollution, diseases, over fishing in some places
Orconectes limosus	No data	Moderate compared to the density	Statistics are available on some big lakes like Bourget or Annecy	Lake Bourget: ($44\ km^2$) 1983: 1 310 kg 1984: 670 kg 1985: 470 kg Lake Annecy: ($25\ km^2$) 1981: 45 kg 1982: 68 kg 1983: 83 kg 1984: 49 kg 1985: 31 kg	No trend observed, probably decreading on Lake Annecy. The reasons is the low value of this kind of catch.
Pacifastacus leniusculus	No data	Heavy on some experimental places	No data	According to the Fishermen's Society the catch is about 120 000 in one year from a lake of 40 hectares	No data

IV VALUE OF CATCHES AND PROCESSING

Table 7. Value, use of catch and foreign trade of crayfish catch in France

Species	1. Value of catches	2. Use of catch	3. Foreign trade import	export
Astacus astacus	No data	Fishermen's own use	Some import, but no precise data. Price 80-100 French francs/kg (1984)	No
Astacus leptodactylus	No data	No data	Over 90 % of the crayfish imported to France are Astacus leptodactylus coming from Turkey. Price 30-80 Frensh francs/kg (1984)	No
Austropotamobius pallipes	No data	Fishermen's own use	No data	No
Orconectes limosus	On lake Annecy about 150-160 French francs/kg (1984).	Fishermen's own use	No	No
Pacifastacus leniusculus	On some places about 100 French francs/kg (1984)	No data	No precise data but possible some import from USA	No

3. Foreign trade

Custom's statistics give the evolution since 1945 of French crayfish consumption entirely based on importations. Crayfish importations grew until 1979 and decreased slightly later to

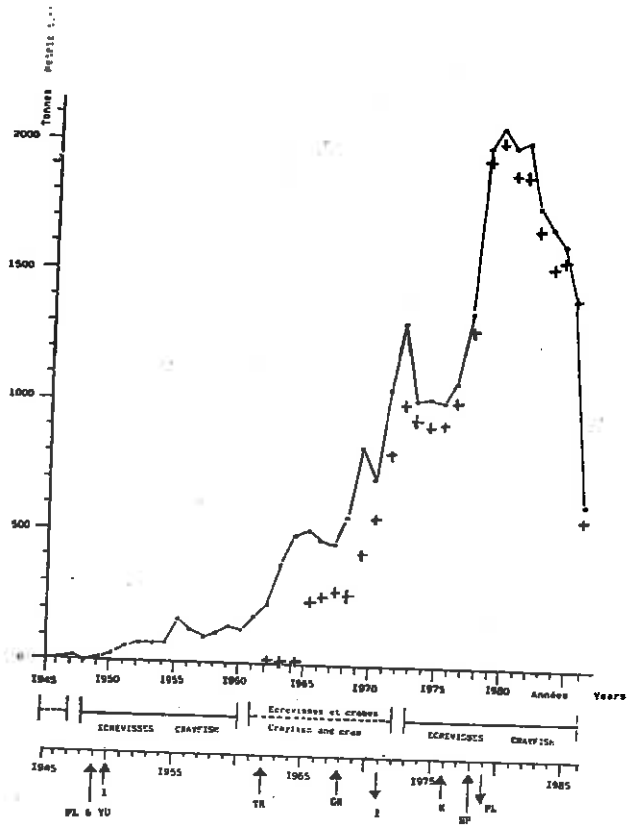


FIGURE 4. Crayfish import in France since 1945.
-•-•-•- total import
+ + + + import from Turkey
Precision of the customs statistics:
I- - - I crayfish identification doubtful
I———I good crayfish identification
beginning of import from a country
end of import from a c.
PL=Poland, YU=Jugoslavia, I=Italy, TR=Turkey, GR=Greece, K=Kenya, SP=Spain.

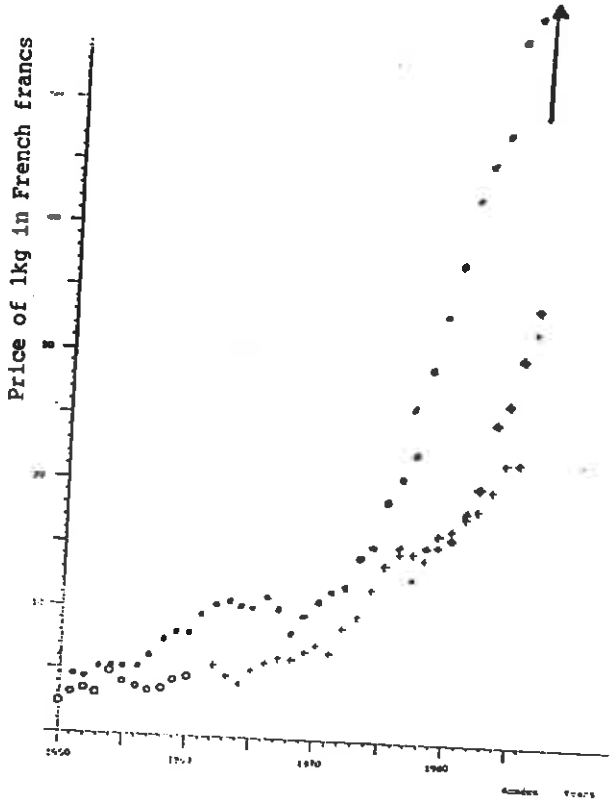


FIGURE 5. Price of one kilo of crayfish (in French francs).
o crayfish from Italy (A. pallipes)
• crayfish from Poland, Jugoslavia, and Greece (A. astacus)
+ crayfish from Turkey (A. leptodactylus)
♦ crayfish from Kenya (P. clarkii)

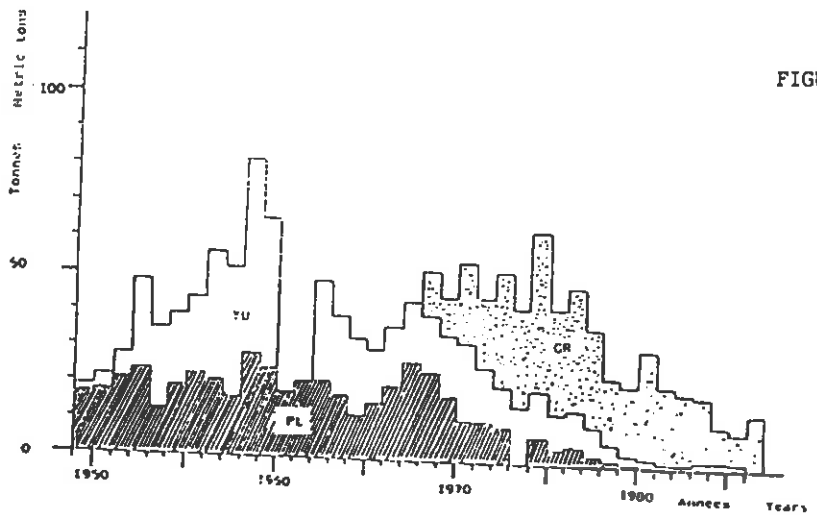


FIGURE 7. Crayfish import from
Poland
Jugoslavia
Greece

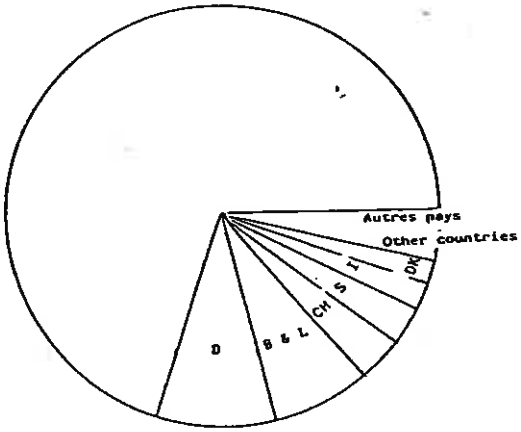


FIGURE 7. Percentage of the Turkish production bought by several countries (1979). Sources Turkish customs statistics. F=France, D=Fed. Rep. Germany, B= Belgium, L=Luxemburg, CH=Switzerland, S=Sweden, I=Italy, DK=Denmark.

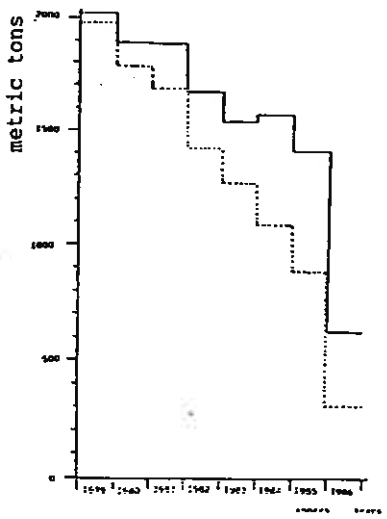


FIGURE 8. Comparison of the data from the French customs statistics with the Turkish ones (crayfish export from Turkey to France).

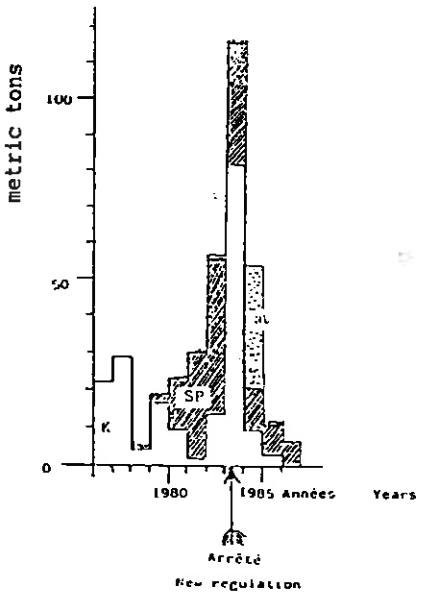


FIGURE 9. Import of Procambarus clarkii from

Kenya

Spain

Netherlands

In July 1983 new regulation: the import of alive P. clarkii is banned.

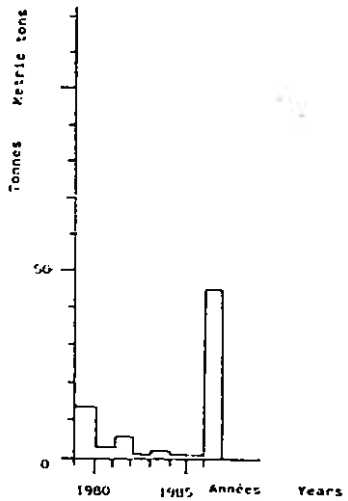


FIGURE 10. Crayfish import from U.S.A.

drop deeply in 1986 after the Turkish production collapsed.

Interpretation based on biogeographic knowledge and commercial value of the species gives indications on the nature of our importations.

Austropotamobius pallipes was imported for a short period from Italy.

Astacus astacus has been sent since forty years by Poland and Jugoslavia and later Greece. But the importations never exceeded one hundred metric tons a year and they reduced with time as price increased. Total disappearance of **Astacus astacus** from our market is to be expected in a near future.

Astacus leptodactylus takes a big development and represents more than 90 percent of our importations for many years. But overfishing and aphanomycosis, since 1985, strongly reduced Turkish production and introduced scarcity on the French crayfish market.

Procambarus clarkii acclimatized to Kenya and Spain is sold to France since 1976 and enters in competition with Turkish crayfish, but a new regulation has banned the importation of **Procambarus clarkii** alive since 1983. The importations of this species are reduced but not totally interrupted.

Crayfish scarcity on French market is a new event; it will give access to new crayfish species, new exporters and new commercial presentations to overcome regulations problems.

Such circumstances are favourable to take new effective regulations for native crayfish protection.

In order to stop the introduction of diseases and undesirable species acclimatization, the regulation of 1983 could be extended to all crayfish species imported to France. Alive crayfish transportations inside France must also be forbidden.

Extensive crayfish farming can be set up with native species on some very favourable places; or with known, healthy foreign species formerly acclimatized to France. These foreign crayfish

must be maintained outside the territory of native ones.

Native ancient populations must be restored everywhere the water quality is convenient. A new tax for crayfish fishing can give the money for such an urgent operation.

Without the necessary decisions, the new aspect of crayfish trade will accelerate the strongly damaged crayfish situation in France.

For more information see the figures 4-10.

V PROTECTION AND MANAGEMENT

1. Regulatory measures

1.1. **Astacus astacus and Austropotamobius pallipes:**
Fishing is allowed 1st August - 15th August, but in many places it is totally forbidden, even for several years (mostly 5).

Astacus leptodactylus and Orconectes limosus:
No regulatory measures.

Pacifastacus leniusculus:
Fishing is allowed generally 15th June - 15th September.
It's allowed to catch only 15 crayfish daily.

1.2. **Astacus astacus and Austropotamobius pallipes:**
Size limitation: only individuals longer than 9 cm can be caught.
Seasonal protection: 16th August - 31th July, often these species are protected for the whole year.
Astacus leptodactylus and Orconectes limosus:
No protection of population.
Pacifastacus leniusculus:
Size limitation: only individuals longer than 12 cm can be caught.
Seasonal protection: generally 16th September - 14th June.

1.3. A new regulation was given July 21st 1983 to protect native crayfish (**Astacus astacus and Austropotamobius pallipes**).

2. Control of alteration of the environment

2.4. Some transplantation experiments with **Austropotamobius pallipes** are in progress.

VI CRAYFISH CULTURE

1. The purpose of crayfish cultivation

Astacus astacus:
There in one crayfish farm to provide stocking material.
Astacus leptodactylus:
There has been one crayfish farming experiment, but it failed and stopped. Production of juveniles for stocking (only allowed in "closed waters").
Austropotamobius pallipes:
No data.
Orconectes limosus:
No data.
Pacifastacus leniusculus:
The purpose is to produce material for stocking.

2. Methods

2.1. Crayfish are fed with corn, wheat, potatoes, fish and pellets.

2.2. They are cultivated in earth ponds and concrete basins.

3. Intensity

3.1. No data.

3.2. There is one farm where **Astacus astacus** is cultivated and one, where **Pacifastacus leniusculus** is cultivated. The most important farm for the cultivation of **Astacus leptodactylus** is closed now.

3.3. No data.

VII PARASITES AND DISEASES

Virus diseases

Not observed.

Bacterial diseases

Astacus astacus:

Septicaemia caused by **Pseudomonas** sp. and **Aeromonas hydrophila.**

Astacus leptodactylus:

Septicaemia caused by **Pseudomonas fluorescens.**

Austropotamobius pallipes:

Septicaemia caused by **Pseudomonas fluorescens** and **P. putida.**

Orconectes limosus and **Pacifastacus leniusculus:**

Not observed.

Fungal diseases

Astacus astacus:

Infections by **Saprolegnia** sp. (comparable to aphanomycosis).

Infections of gills by **Fusarium** sp. These infections are scarce.

Astacus leptodactylus:

Infections by **Saprolegnia** sp. (comparable to aphanomycosis).

Infection of the gill by **Fusarium roseum** var. **cuilmorum** and of carapace by **Fusarium solani.**

Austropotamobius pallipes:

Burned spot disease discovered in 1983. Infections caused by Saprolegniales, particularly **Saprolegnia diclina.**

Orconectes limosus:

Aphanomyces astaci - one natural population recognized as chronically infected. Fungal infections of eggs by Saprolegniales. These infections are scarce.

Pacifastacus leniusculus:

Infections of eggs by **Dictyuchus** sp. Wound infections by **Fusarium** sp.

Protozoan diseases

Astacus astacus:

White tail disease (**Thelohania contejeani**)

Astacus leptodactylus:

White tail disease; infections are scarce.

Psorospermium haeckeli; infections are abundant.

Austropotamobius pallipes:
White tail disease; infections are abundant.
Psorospermium haeckeli; infections are scarce.
Orconectes limosus:
White tail disease; infections are scarce.
Pacifastacus leniusculus:
Psorospermium haeckeli

Helminths
Astacus astacus:
Branchiobdella sp.
Astacus leptodactylus: -
Austropomotabius pallipes: -
Orconectes limosus: -
Pacifastacus leniusculus:
Branchiobdella sp.

5. Preventive measures and treatment

5.1. Legislation

In order to stop the introduction of diseases and undesirable species acclimatization, the import of alive **Procambarus clarkii** is banned since 1983.

FEDERAL REPUBLIC OF GERMANY

H. Kuhlmann

I SPECIES, ORIGIN, GEOGRAPHICAL DISTRIBUTION

1.-2. Nomenclature and origin of the species (Table 1)

Table 1. Scientific and common names of the species. Origin of the species and if introduced the main purpose. (Number refers to the questionnaire. For complete questions, see the questionnaire.)

1.1. Scientific name(s)	1.2. Common name(s)/ in English	2. Origin of the species
Astacus astacus	Edelkrebs/ Noble crayfish	Native
Cambarus affinis (Orconectes limosus)	Camberkrebs/ Amerikanischer Krebs/ American crayfish	Imported in 1980 from USA for pond-stocking. Now main crayfish in the national waters of the State of Berlin. In the 20th century it has been imported to other States.
Pacifastacus leniusculus	Signalkrebs/ Signal crayfish	Imported first 1973 from the Columbia River and the Lake Almanoe for artificial breeding and stocking of ponds and natural waters and for aquaculture.
Astacus leptodactylus	Sumpfkrebs galizier/ Swamp crayfish	Imported from Turkey

3. Distribution

3.1.-3.6. Table 2.

Table 2. Distribution of the crayfish species in the Federal Republic of Germany

Species	3.1. Geographical distribution	3.2. Description of the habitats	3.3. Determinants of distribution	3.4. Changes in distribution areas	3.5. Frequency in the distribution area (% of waters)	3.6. Hybridization
Astacus astacus	The whole country.	Brooks, rivers, lakes, bogs, deep and fast-flowing waters with sand, mud clay or gravel bottom	No restrictions in distribution with respect to temperature. Water course constructions, crayfish plague, predators: eel, carp, heron, raven. Pollution affects heavily.	Increasing	0 - 25 %	There have been some attempts of hybridization (A.astacus x A.leptodactylus). No further information available.
Cambarus affinis (Orconectes limosus)	The whole country. Main distribution area may be the State of Berlin, but it is numerous also in Schleswig-Holstein.	Shallow and flowing waters	As Astacus astacus		0 - 25 %, except in Berlin 100 %	
Pacifastacus leniusculus	The whole country		Prefers higher temperature than Astacus astacus, otherwise as it	Increasing	0 - 25 %	
Astacus leptodactylus	The whole country		As Astacus astacus			

II POPULATION

1. Abundance and density of population

1.1. Sparse - rather sparse, except in Berlin: fairly abundant.

1.2. Sparse - rather sparse, except in Berlin: fairly abundant.

1.3.-1.4. In general increasing stocks, but locally decreasing due to: intensive stocking with eel, crayfish-plague, water course constructions, overfishing because of lack of legislative regulations. Pollution causes a reduction of reed, where especially C. affinis preferably hides when moulting.

III EXPLOITATION

1. Fishermen

1.1. 6

1.2. 40 - 50 (estimated)

1.3. 40 - 50 (estimated)

2. Basis for the crayfish fisheries

2.1. Crayfish catching is free.

2.2 The owner of the water area can catch crayfish, if he has the fishing license.

2.3. Catching areas are hired for fishing in general, this means fishing on crayfish too. Legislation may be different in the single states.

2.4. It is not allowed to use crayfish as a bait.

3. Fishing methods and equipment

3.1. Hand picking only by sport-fishermen, fyke-nets occasionally when fishing fish with purse-seine.

3.2. Normal fyke-nets for eel, special fyke-nets for crayfish (meshwire) but meshsize not known; all with baits.

4. Since when has the species been exploited

A. astacus: since several centuries.
C. affinis: ca. 1938.
P. leniusculus: since 1973.
A. leptodactylus: ?

5. Fishing season

5.1. From May to October with differences in the single states, Cambarus for excample in the state of Schleswig-Holstein all the year round.

6. Fishing operations and results

6.1. No data available.

6.2. Light in general, except in the State of Berlin, where exploitation is intensive.

6.3. No statistics available, except from Berlin where an official annual catch-statistics exists and where persons with a fishing licence have to report obligatorily.

6.4. In 1961 the official inland-fisheries statistics reports an annual catch of 10 688 kg with respect to only 5 states of the Federal Republic of Germany.
In 1984 the two states Berlin and Schleswig-Holstein report an annual production (1983) of all together 9 600 kg. The estimation of our most experienced crayfish-farmer is that the difference between "official production" and real production is 40-50 t p.a.
Minimum size of crayfish is, depending on the legislation of the states, between 8 and 11 cm, this means an average weight of ~ 60 g.

7. Changes in catches and the reasons for the changes during the last ten years and/or earlier

In general the crayfish-stocks are slowly increasing, but in some regions they are decreasing, especially the stocks of A. astacus. There are different reasons for decreasing stocks, mainly overfishing and pollution.

IV VALUE OF CATCHES AND PROCESSING

Table 5. Value, use and foreign trade of the crayfish catches in the Federal Republic of Germany.

Species	1. Value of catches	2. Use of catch fishermen's own use	for sale	3. Foreign trade import	export
Astacus astacus	30 - 40 DM/kg animals over 15 cm ~ 70 DM	Yes	Yes	Annual import is estimated to be ~ 100 t	
Cambarus affinis	20 - 25 DM/kg	Yes	Yes		
Pacifastacus leniusculus	as A. astacus	Yes	Yes		
Astacus leptodactylus	20 - 25 DM/kg	Yes	Yes	Annual import in estimated to be ~ 200 t	

V PROTECTION AND MANAGEMENT

1. Regulatory measures

1.1. No limitations.

1.2. Generally no limitations, in some states closed season (November - May) and minimum size 8 - 11 cm (only for A. astacus).
In some states females are protected, in some states only females carrying eggs.

2. Control of alteration of the environment

2.1. Water course constructions are carried out more carefully and more sensitively to biological conditions.

2.3. People become more conscious of the interaction between fish-stocks and crayfish-stocks. Especially cyprinids are intensively fished out where crayfish-stocks are growing. Very intensive stocking of natural waters with eels becomes more and more problematic.

2.4. Stocking is done with young crayfish, mainly of about 2 - 5 g (A. astacus and P. leniusculus) for maintainance, transplantation and introduction (the latter only for P. leniusculus).

3. Other measures

In some states eel stockings in natural waters with crayfish are forbidden.

VI CRAYFISH CULTURE

1. The purpose of crayfish cultivation

The purpose is to produce stocking-material and crayfish of edible size.

2. Methods

2.1. Food and feeding very diversified; fish, carrot, potatoes, apples. A formulated diet is used mainly for P. leniusculus.

2.2. Basins and ponds are used.

3. Intensity

3.1. Some 10 000 young and 3 000 - 5 000 edible size.

3.2. About 10 crayfish farms.

3.3. Total pond area between 1 and 2 hectare per farm. Basins between 1 and 5 m^2 each, total between 10 and 30 m^2 per establishment.

VII PARASITES AND DISEASES

Virus diseases
Not recorded.

Bacterial diseases
Not recorded.

Fungal diseases
Crayfish plague (**Aphanomyces astaci**).

1. Crayfish species
Astacus astacus

2. Origin of the disease

1860 Italy (Lombardei).
1870 Southern France.
1878 Baden-Württenberg (Southern Germany).
1880 Bayern (Southern Germany).
1881 Area of the River Oder (Eastern Germany).
1884 Area of the River Weichsel (Eastern Germany).
1890 Russia.

Crayfish trade promotes the spread of disease as well as the decreasing water quality.

3. Distribution

Crayfish plague flames up from time to time in different regions of the country. No real spreading from one region to an other is reported.

4. Significance

When crayfish plague occurs, normally 100 % of the stock in both natural waters and under artifical conditions die. This is of great importance to the crayfish culture.

5. Preventive measures and treatment

5.1. No legislation.

5.2. Daily treatment with malachite-green (1 - 2 g/10 m^3) may prevent new infection by spores, but does not cure infected animals from crayfish plague. In Germany the usage of malachite-green is not allowed.

5.3. No information.

1. Crayfish species
Pacifastacus leniusculus.

2. Origin of the disease
-

3. Distribution
-

4. Significance

P. leniusculus is reported to be less sensitive than A. astacus to the plague. Pacifastacus may carry Aphanomyces without any signs of the disease.

Burned spot disease: **Ramularia astaci.**
Didymaria cambari.

Protozoan diseases

White tail disease (**Thelohania contejeani**): reported, but not with relation to species.

Helminths

Branchiobdella variants.

1. Crayfish species
Astacus astacus

2. Origin of the disease
-

3. Distribution

-

4. Significance

-

5. Preventive measures and treatment

5.2. A bath with CaO (100 g/10 l water) has been reported to be successfull.

5.3. No information.

- Distomum cirrigerum (intestines).

Tumors

Not reported.

GREECE

G. Kallistratos

I SPECIES, ORIGIN, GEOGRAPHICAL DISTRIBUTION

1.-2. Nomenclature and origin of the species (Table 1)

Table 1. Scientific and common names of the species. Origin of the species and if introduced the main purpose. (Number refers to the questionnaire. For complete questions, see the questionnaire).

1.1. Scientific name(s)	1.2. Common name(s)/ in English	2. Origin of the species
Astacus fluviatilis	Karavida/crayfish	Native
Astacus leptodactylus		Introduced

3. Distribution (Table 2).

Table 2. Distribution of the crayfish species in Greece

Species	3.1. Geographical distribution	3.2.Description of the habitats	3.3. Determinants of distribution	3.4. Changes in distribution areas	3.5. Frequence in the distribution area (% of waters)	3.6. Hydridi-zation
Astacus fluviatilis	Lake of Ioannina, Rivers: Kalamas, Louros, Melos, Larissa, Metsovo	Rivers, lakes, basins-mountain areas, plain-deep, shallow, fast or slow flowing waters	All the determi-nants mentioned in the question-naire but tempe-rature mainly	Tremendous decreases of the crayfish populations probably due to human intervation and pollution	0 - 25 %	-

II POPULATION

1. Abundance and density of the crayfish population (Table 3)

Table 3. Abundance and density of the crayfish population in Greece.

Species	1.1. Average abundance in the distribution area	1.2. Population size and density in different habitats	1.3. Changes in abundance	1.4. Reasons for the changes
Astacus fluviatilis	Rather sparse	Rather scarce	Descreased	Disease, pollution

III EXPLOITATION

1. Fishermen

1.2. About 25.

2. Basis for the crayfish fisheries

2.1. Crayfish catching is free.

3. Fishing methods and equipment

3.1 Hand picking, nets.

4. Since when has the species been exploited

Astacus fluviatilis has been exploited for the last 50 years.

5. Fishing seasons

5.1. May - September and in December.

6. Fishing operations and results

6.1. 500 - 1000 kg/day.

6.2. The exploitation is light.

6.3., 6.4. and 7.
Until 1981 the catch/day was of the above degree in Ioannina, (N.W. Greece) district. But after 1981 all crayfish dissappeared due to crayfish plague. There are still crayfish catching in Larissa and Metsovo where crayfish are not infected due to their situation (higher altitute).

IV VALUE OF CATCHES AND PROCESSING

Table 4. Value, use and foreign trade of the crayfish catches in Greece.

Species	1. Value of catches	2. Use of catch		3. Foreign trade	
		fishermen's own use	for sale	import	export
Astacus fluviatilis	400 drachmas/kg	? (All sorts of water use)		-	Most of catches are exported to France

V PROTECTION AND MANAGEMENT

1. Regulatory measures

1.1. There is only seasonal limitation (not legislation).

2. Control or alteration of the environment

2.2. Elementary pollution control.

VI CRAYFISH CULTURE

There is no crayfish cultivation procedures running.

VII PARASITES AND DISEASES

Virus diseases

Bacterial diseases

Fungal diseases

Crayfish plague (Aphanomyces astaci).

1. Crayfish species

   Astacus leptodactylus.

2. Origin of the disease

3. Distribution

3.1. **Crayfish plague (Aphanomyces astaci) has affected crayfish populations all over Epirus and there have been very few left in the last 2 years.**

4. Significance

5. Preventive measures and treatment

   No protective measures have been adapted.

HUNGARY

Z. Thuránszky, K. Pinter

I SPECIES, ORIGIN, GEOGRAPHICAL DISTRIBUTION

1.-2. Nomenclature and origin of the species (Table 1)

Table 1. Scientific and common names of the species. Origin of the species and if introduced the main purpose. (Number refers to the questionnaire. For complete questions, see the questionnaire.)

1.1. Scientific name(s)	1.2. Common name(s)/ in English	2. Origin of the species
Astacus astacus	Folyami rák / -	Native
Astacus leptodactylus	Kecskerák / -	Native; but also introduced from Poland in the last decades of this century, to replace the decaying stocks of A. astacus
Astacus torrentium	Kövirák / -	Native
Cambarus affinis	Cifrarák / -	Introduced in 1960, on experimental basis

Previously there has been a fifth species Astacus pallipes / csókarák - which vanished from Hungarian waters during the end of the last century.

3. Distribution (Table 2)

A survey on Hungarian crayfish stocks has been prepared during the years 1956 - 1962. About 22 000 km of brooks, channels, temporary creek-beds, creeks, minor rivers and lakes were examined during this time. Changes since then are not registrated, only sporadic informations are at disposal.

Table 2. The distribution of the crayfish species in Hungary.

Species	3.1. Geographical distribution	3.2. Description of the habitats	3.3. Determinants of distribution	3.4. Changes in distribution areas	3.6. Hybridi-zation
Astacus astacus	In Northern and Western Hungary in the highland regions	Upper reaches of the brooks and creeks Exeptionally in small lakes (population origi-nates from introductions). Waters are shallow, flowing fast or slow. Brook bed is clay, stony or peaty	1) Diseases, esp. crayfish plague. 2) Changes of the environmental conditions: - conversion on the brooks - water pollution has effect on single stocks	No changes in the last 20 years (1	Not observed
Astacus leptodac-tylus	In central and eastern parts of the country, in the Hungarian plain (see the map)	In all bigger rivers, channel, back-banches and some bigger lakes in lowlands. In slowly flowing or stagnant waters. Even in slimy and marshy sites	1) Temperature, it is present only in warm waters 2) Diseases	Gains area and is spreading in lowland waters	"
Astacus torrentium	In seven creeks north from Buda-pest (see the map)	In small shallow, story and fast flowing creeks with very small amount of water	-	-	"
Cambarus affinis	In three small isolated ponds near Budapest				

1)Astacus astacus was present practically in all waters of Hungary before the Sixties of the last century. The crayfish plague reached Hungary in seventies of that century. The plague destroyed almost completely A. astacus stocks. Recovery of stocks started from the upmost reaches of some brooks and creeks.

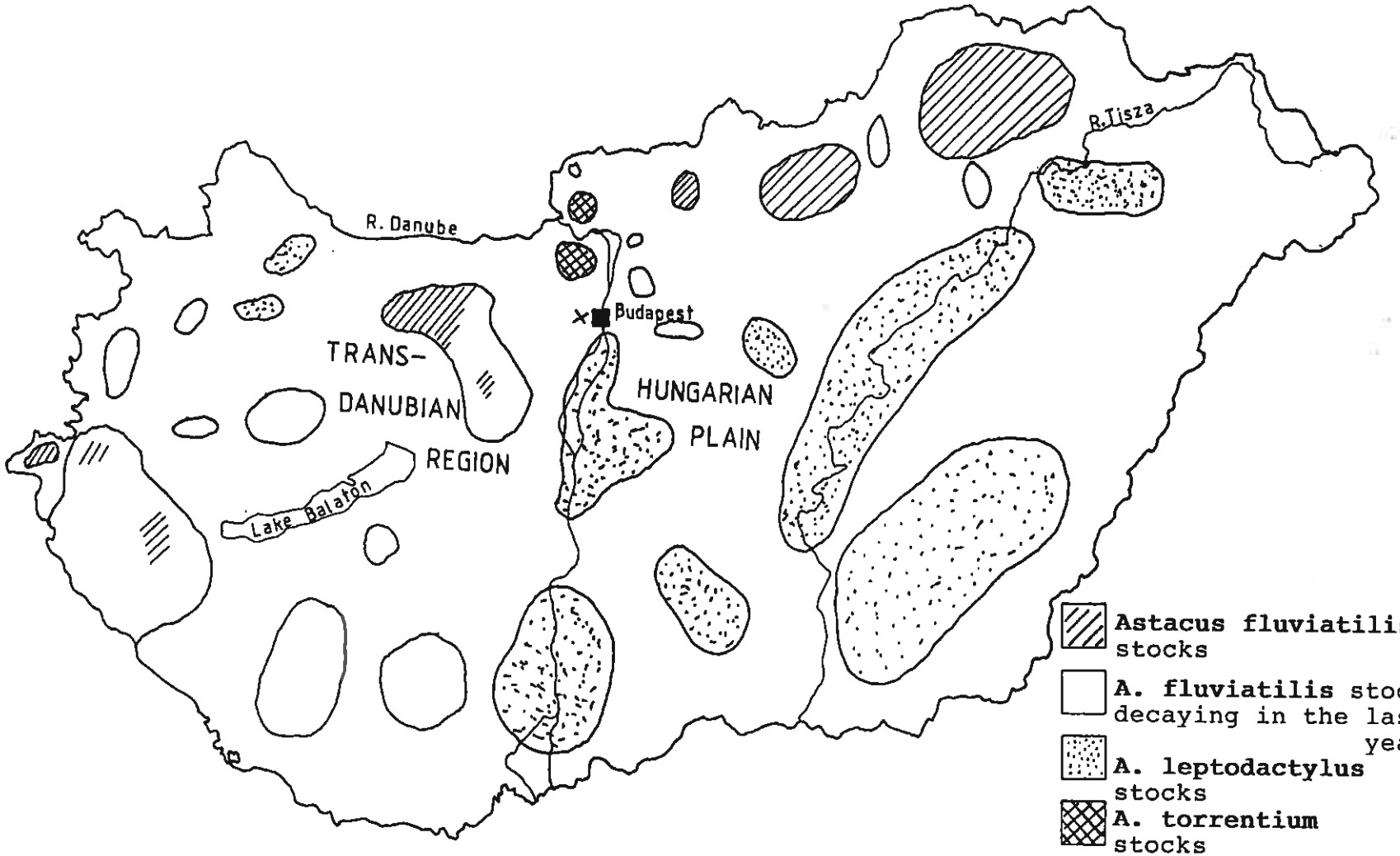


FIGURE 1. The distribution of crayfish species in Hungary.

II POPULATION

1. Abundance and density of the population (Table 3)

Table 3. Abundance and density of the crayfish population in Hungary.

Species	1.2. Population size and density in different habitats	1.3. Changes in abundance	1.4. Reasons for the changes in abundance
Astacus astacus	In some few brooks dense, elsewhere rather scarce	Dramatic decrease during the last 20 years. Changing tendencies before that	1) river draining 2) pollution (both industrial and agricultural) 3) diseases (plague)
Astacus leptodactylus	In few natural waters mainly back-branches, dense, in lowland waters scarce	No significant changes 1)	-
Astacus torrentium	Very dense	No changes in the last 20 years	
Cambarus affinis			

1) It seems as if the species would gain in populated area.

III EXPLOITATION

1. Fishermen

1.2 1960: about 100 semi-professional fishermen.
1980: about 10 - 15 - " -
1986: about 10 - " -

2. Basis for the crayfish fisheries

For catching crayfish an official permit and a territorial license is needed.

3. Fishing methods and equipment

3.2. Crayfish-balances are used baited with some kind of meat. Diameter of the balance is about 30 cm.

4. Exploitation

Exploitation can be tracked back to the 15th century.

5. Fishing stocks

5.1. **A. astacus** : from 1.6. to 15.10.
A. leptodactylus: all the year round.
A. torrentium : under protection (no catch permitted).

6. Fishing operations and results (Table 4)

Table 4. Catches per unit fishing effort, degree of exploitation, catch statistics and total annual catch of crayfish in Hungary. Information concerning the all three species united.

6.1. Catch per unit/ fishing effort	6.2. Degree of exploitation	6.3. Catch statistics available	6.4. Total annual catch
2 - 40 kg/day/man	Moderate (the whole country)	-	1) 1956: 13 tons 1980: 1 ton 1986: 1 ton

1) Reasons for decreasing catches: decay of stocks and low number of fishermen as a consequence of low price of crayfish.

IV VALUE OF CATCHES AND PROCESSING

1.-2. No data available.

3. Foreign trade

Export of **A. astacus** (1986): about 200 kg.

V PROTECTION AND MANAGEMENT

1. Regulatory measures

1.2. From 1977 the minimum catchable size for A. astacus is 10 cm.
There are also limited fishing seasons for A. astacus (see 5.1.)

2. Control or alteration of the environment

2.1.-2.3. Only general rules of water-protection are valid. There exist no special regulations for protection of crayfish stocks.

2.4. The transplantations of A. astacus were made in the years 1911, 1923 - 24, 1938 - 39 and 1959 - 60 in North-Hungary and in Trans-Danubia.
A. leptodactylus is also introduced to replace the decaying stocks of A. astacus.

VI CULTURE

Exept for one occasion in 1965, when 500 crayfishes with eggs were kept in a special basin and the hatched fry reared for some months after removal of spawners, no effort for propagation has been carried out. The fry gained was destroyed by crayfish-plague. At the moment there are no crayfish farms in the country.

VII PARASITES AND DISEASES

Virus diseases: -
Bacterial diseases: -
Fungal diseases: -

Aphanomyces astaci

Observed several times in Astacus astacus. Probably effecting also other Astacus species (no report available in this respect).

According to some available reports A. astacus was present practically in all waters of Hungary before the sixties of last century. The crayfish plague, Aphanomyces astaci reached Hungary in the seventies of that century. The

plague destroyed almost completely **A. astacus** stocks throughout the whole country, exept for the upmost reaches of some brooks and creeks. Recovery of stocks started from these places.
Burned spot disease: It can be found on **A. astacus** especially in dense stocks and certain brooks.
Less freguent in **A. leptodactylus**

Helmints
Branchiobdellidae: It is found almost on every specimen of each species.

VIII ADDITIONAL INFORMATION

Cold-water crayfish.

Crayfish traders in Hungary make a difference between **A. astacus** coming from cold and warm water.
The first's survival during transportation is poor as compared to the warm-water crayfish. Examinations of different stocks revealed, that there are some slight morphological differences in the two types. The size (probably growth also) of the "cold-water" type is smaller compared to that of the "warm-water" type.

IRELAND

J. D. Reynolds, J. Lucey, C. O'Keeffe, C. Moriarty

I SPECIES, ORIGIN, GEOGRAPHICAL DISTRIBUTION

1.2. Nomenclature and origin of the species (Table 1)

Table 1. Scientific and common names of the species. Origin of the species and if introduced the main purpose. (Number refers to questionnaire. For complete quetions, see the questionnaire.)

1.1. Scientific name(s)	1.2. Common name(s)/ in English	2. Origin of the species
Austropotamobius pallipes	Crayfish, Freshwater crayfish	Presumed native. Early literature suggests it may have been introduced, but this is common in the history of Irish fauna and does not often stand up to investigation. Crayfish may, however, have been imported into Dublin from Great Britain in the nineteenth century as a food item. There are no records of imports for stocking purposes, but there are scattered references in 18th and 19th century papers of movement of stocks within the country; e.g. from Kildare to Antrim.

3. Distribution

Distribution of the crayfish in Ireland, Table 2.

Table 2. Distribution of the crayfish in Ireland.

Species	3.1. Geographical distribution	3.2. Description of the habitats	3.3. Determinants of distribution	3.4. Changes in distribution areas	3.5. Freguency in the distribution area	3.6. Hybridization
Austropotamobius pallipes	See the map. Widespread troughout the limestone lowlands of the country. Absent from granitic coastal highlands, and acidic sandstone south-West. One exception, the Awbeg tributary of the R. Blackwater, may be the result of introductions? The most westerly fluvial population was at a site on the Westpoer river. With a longitude of 9° 32"W this site is further west than the Atlantic coast of Portugal and northern Spain and these crayfish are among the most westerly populations in Europe.	Believed to be most plentiful in brooks. Rare in large lakes, plentiful in a small number of small, landlocked lakes. Plentiful in some lowland rivers absent from others. Appears eurytopic occurring on eroding and depositing substrata in rivers/streams.	Rare above 200 m altitude perhaps because of low summer temperatures inhibiting growth. Topographically high areas that also act as barriers in extending range. Such areas are associated with base poor resistent bedrock and this is reflected in the low ionic concentration of the streams and rivers. The streams/rivers from which A. pallipes was recorded had the following ranges: pH 7.2 - 8.4, alkalinity 34 - 356 mg/l, hardness 47 -402 mg/l. Diseases probably unimportant in restricting range. Predation esp. by eels may account for some restrictions, e.g. in the R. Bann. Also pike are apparently important predators. Pollution may restrict range in some rivers.	Discussed in Reynolds (1983). Crayfish no longer occur in Dublin rivers due to pollution. There has also been some restriction of range in more acid streams, e.g. River Slaney (Wexford), R. Foyle (Donegal) where stocks were formerly noted.	25 - 50 %	A. pallipes is the only species recorded

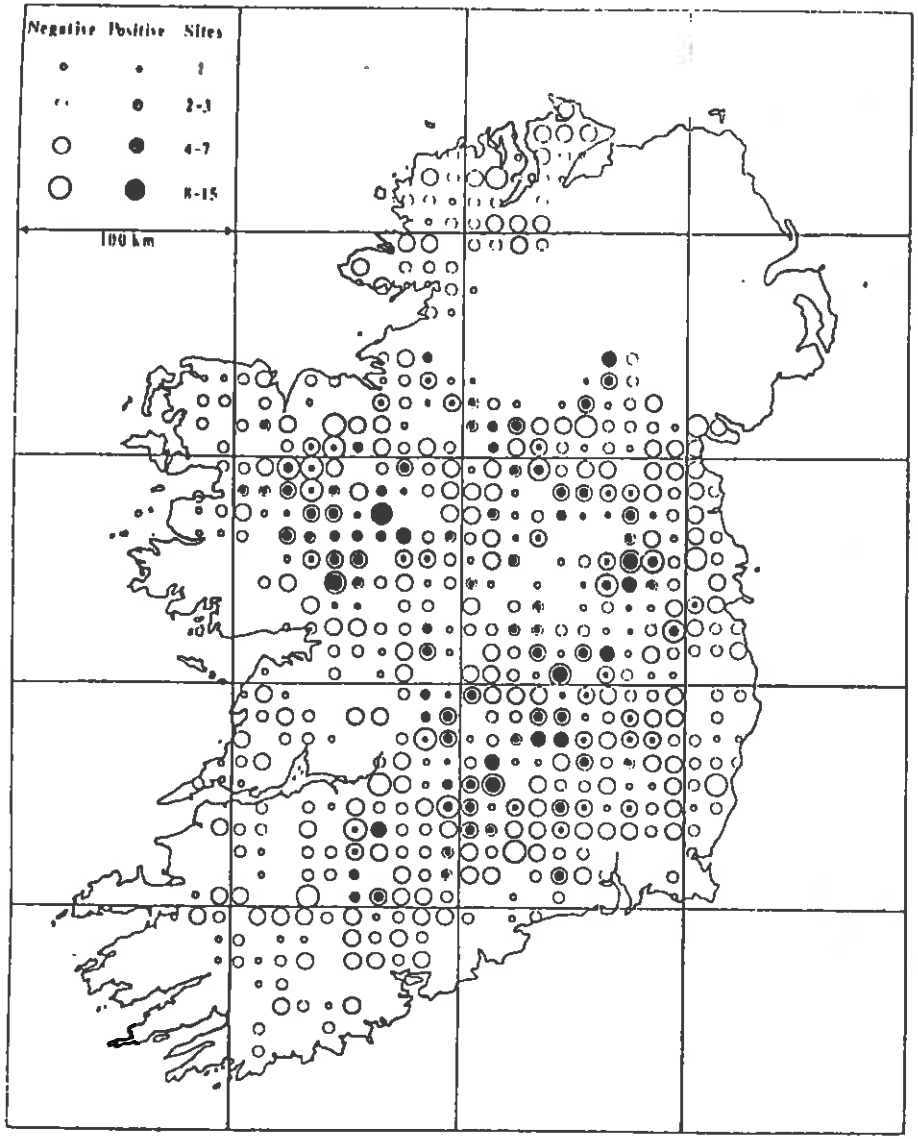


FIG. 1. The distribution of *Austropotamobius pallipes* in regularly sampled rivers and streams in Ireland (Republic) from records collected since 1976 and based on 10 km^2. Open circles represent the sites sampled which were negative and the solid black circles are the sites where the species has been found; the size of the circle indicates the number of sites in that 10 km square.

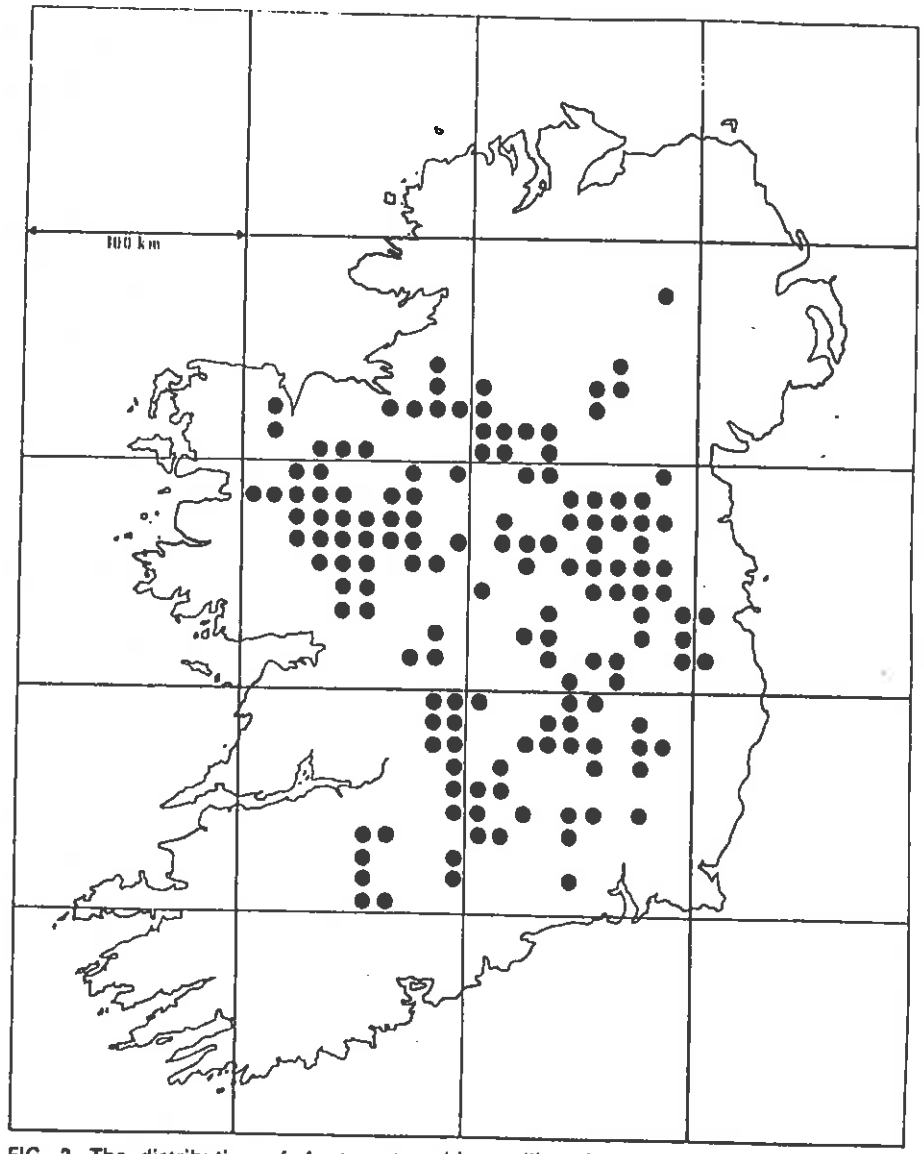


FIG. 2. The distribution of *Austropotamobius pallipes* in Ireland from records collected since 1976, based on presence in 10 km squares.

II POPULATION

1. Abundance and density of the crayfish populations in Ireland (Table 3)

Table 3. Abundance and density of the crayfish population in Ireland.

Species	1.1. Average abundance in the distribution area	1.2. Population size and density in different habitats	1.3. Changes in abundance	1.4. Reasons for the changes
Austropotamobius pallipes	See map for site abundance within 10 km squares. Density at river sites ranges from sparse to fairly abundant. Rather sparse in larger rivers, fairly abundant in some smaller streams and in particular in ponds and streams in Counties Fermanagh-Monaghan-Cavan (Erne System).	Fairly dense in suitable habitats, e.g. Lisheens stream, Co. Wicklow, average 50 crayfish in 100 m stretch caught. E.g. White Lake Co. Westmeath, several per square meter, and about 70 sub-yearlings per sq.m. in shallows and Chara. (Reynolds, O Keeffe)	Occasional records of catastrophic decline of local stocks, but in many cases these have been succeeded by a buildup of stocks after some years. Permanent changes have not been observed.	Predation is suspected to be the reason for the occasional changes. Older changes in abundance or collapses of populations may be attributable to agricultural practices or local pollution.

III EXPLOITATION

1. Fishermen

Table 4. Number of fishermen

1.1. professional fishermen	1.2. Semi-professional	1.3. Subsistence and recreational
0	Reynolds and O'Keeffe know one man who attemps to sell crayfish, but this propably accounts for very little of his income.	Probably 10 - 20

2. Basis for the crayfish fisheries

2.1. No restrictions are in force.

3. Fishing methods and equipment

3.1. Hand picking, traps.

3.2. Small, portable traps.

4. Since when has the species been exploited?

Occasional records from 18th and 19th century describe crayfish use as luxury food, so a light level of exploitation may have occured in some areas (Reynolds, O'Keeffe). In this century, there are no records prior to 1965 (Moriarty).

5. Fishing season

5.1. No close season, crayfish may be caught in every month.

6. Fishing operations and results

6.1. Up to 25 crayfish per rigid, plastic trap fished overnight and baited with beef liver (Moriarty).

During Lucey's surveys of rivers/streams the largest catch was 27 specimens for sampling effort of 5 minutes using handnetting.

6.2. Light.

6.3. Not available.

6.4. Less than 1 tonne per annum.

7. Changes in catches and the reason for the changes during the last ten years and/or earlier.

Probably no exploitation prior to 1965 when Swedish expatriates developed a small fishery for personal consumptiom.

IV VALUE OF CATCHES AND PROCESSING

1. Value of catches

0

2. Use of fishing areas

Fishermen's own use.

3. Foreign trade

0

V PROTECTION AND MANAGEMENT

1. Regulatory measures

No regulations.

2. Control or alteration of the environment

2.1. Under the Arterial Drainage Act 1945 many rivers in Ireland are dredged to alleviate flooding effects. In the course of such operations large numbers of crayfish can be removed with the dredged material; such operations can also destroy or alter the habitat. Some evidence has been collected which indicates that the abrasive action of particles carried in suspension can lead to mechanical injury which

can promote fungal lesions in crayfish and may eventually cause death, possibly through osmoregulatory dysfunction. A site examined in 1980 which was not dredged but upstream and downstream sites were being excavated contained 27 specimens of which 30 % had fungal excrescence. Two years later a follow up examination of the site at the same time of year yielded only 1 specimen for the same sampling effort (Lucey).

3. Other measures

VI CRAYFISH CULTURE

1. The purpose of crayfish cultivation

Several salmonid fish farmers have expressed interest in experimental culture of crayfish, but the economics seem unattractive (Reynolds, O'Keeffe).

2. Methods

2.1.-2.2. One person runs a small holding-feeding facility. Crayfish are collected from surrounding waters and held in mesh cages in a small lake. They are fed roach. This is very small-scale (Reynolds, O'Keeffe).

VII DISEASES

Virus diseases

Not observed.

Bacterial diseases

Not observed.

Fungal diseases

Crayfish plague (Aphanomyces astaci).

Austropotamobius pallipes.

Crayfish plague was identified in Ireland in end September, 1987. It struck Lough Lene near Mullingar, Co. Westmeath, and was brought into an experimental crayfish farm killing all stocks.

Plague may have entered the country in about 1985, perhaps into

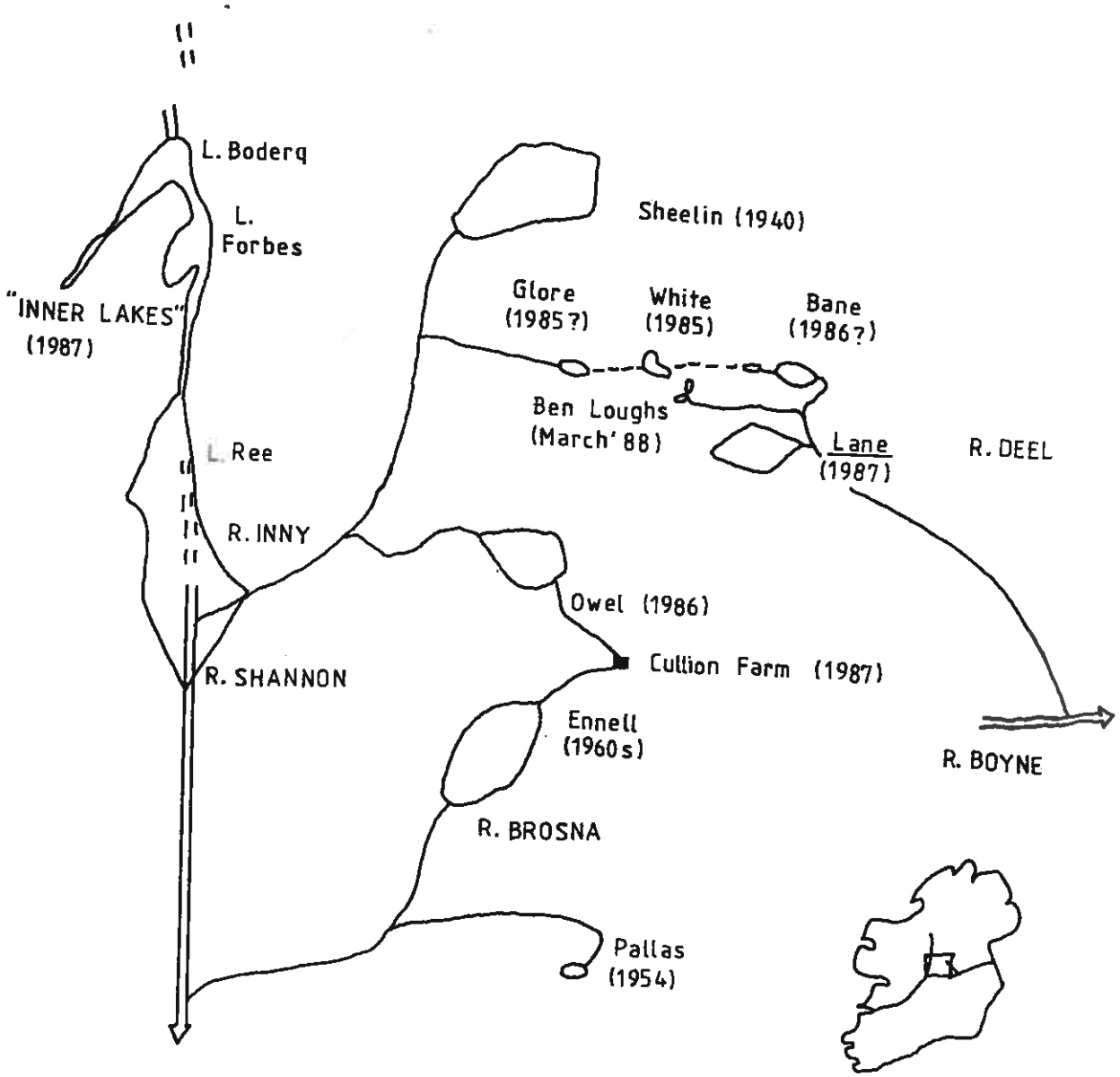


FIGURE 3. Known or suspected plague outbreak sites in Ireland, with date of outbreak.

White Lake (studied by Moriarty), and perhaps by agency of fishermen - for crayfish or coarse fish. It has since spread to eliminate crayfish from White Lake, L. Lene, L. Bane, L. Gore, L. Owel and there is a suggested outbreak on the upper Shannon River.

This has caused considerable concern, not least among those seeking to uphold the prohibition on importations. There is however no new legislation or controls planned.

Burned spot disease.

1. **Austropotamobius pallipes**

2. Origin of the disease

2.1. The first notes have been made by O'Keeffe and Reynolds, 1983-

3. Distribution

4. Significance

4.2. Burn-spot disease is rare and perhaps caused by fungal infection of an abrasion. It is most frequent in adult males (Reynolds, O'Keeffe).
The disease was noted in 3 % of one lake population (Reynolds).

5. Preventive measures and treatment

Protozoan diseases
White tail disease (Thelohania contejeani)

1. Crayfish species
Austropotamobius pallipes

2. Origin of the disease

2.1. The first records of the disease have been made by O Keeffe and Reynolds, 1983.

3. Distribution

3.1. The disease occurs in crayfish in tributaries of the Erne, Shannon, Liffey, Suir and Boyne. It has been noted in one lake population too.

4. Significance

4.2. Detailed surveys of 914 stream crayfish showed 1,2 % with Thelohania, and of 2 676 lake crayfish, 0,7 %. It is thus widespread, but rare.

Helminths
Not observed

Tumors
Not observed

Others
Not observed

ITALY

A. Mancini

I SPECIES, ORIGIN, GEOGRAPHICAL DISTRIBUTION

1.-2. Nomenclature and origin of the species (Table 1)

Table 1. Scientific and common names of the species. Origin of the species and if introduced the main purpose. (Number refers to the questionnaire. For complete questions, see the questionnaire.)

1.1. Scientific name(s)	1.2. Common name(s)/ in English	2. Origin of the species
Astacus astacus	Gambero di fiume, Gambero d'acqua dolce/ River crayfish, Freshwater crayfish	Native
Astacus leptodactylus	Gambero turco/ Turkish crayfish	Introduced from Turkey in the last 10 years to compensate for the scarce availability of local crayfish
Astacus pallipes	Gambero di fiume, Gambero d'acqua dolce/ River crayfish, Freshwater crayfish	Native
Procambarus clarki	Not known, probably Gambero rosso/ Red crayfish	Introduced from Kenya, in 1983, for experimental breeding

3. Distribution

Distribution of the crayfish species in Italy, Table 2.

II POPULATION

Abundance amd density of the crayfish populations in Italy, Table 3.

Table 2. Distribution of the crayfish species in Italy

Species	3.1. Geographical distribution	3.2. Description of the habitats	3.3. Determinants of distribution	3.4. Changes in distribution area	3.5. Frequency in the distribution area (% of waters)	3.6. Hybridization
Astacus astacus	Very marginally distributed, it is found only in the region bordering Yugoslavia	Ponds, rivers	Unknown	Unknown	Unknown	Not observed
Astacus leptodactylus	One lake in Central Italy; possibly in other places	Lake	Unknown	Unknown	Unknown	Not observed
Astacus pallipes	The most widespread species in Italy, it can be found practically all over Northern and Central Italy, reaching South down to Calabria	Brooks, small rivers, sources of rivers, small lakes, mountain and hill streams	Temperature, diseases, poaching, pollution, concrete river banks, predation	Become rare almost everywhere over the last 10-20 years but without substantial changes in distribution	0-25 % in Central and Southern Italy (in some areas 25-50%)	Not observed
Procambarus clarkii						

Table 3. Abundance and density of the crayfish populations in Italy

Species	1.1. Average abundance in the distribution area	1.2. Population size and density in different habitats	1.3. Changes in abundance	1.4. Reasons for the changes
Astacus astacus	Unknown	Unavailable data	Unavailable data	Unavailable data
Astacus leptodactylus	Unknown (studies under way)	Unavailable data (studies under way)	Unavailable data	Unavailable data
Astacus pallipes	Rather sparse	Unavailable data (studies under way)	Several populations extinct or considerably reduced in rivers and lakes of Central Italy. Data for Northern Italy unavailable	Pollution, poaching, man-made environmental alterations, possibly crayfish plague or other diseases
Procambarus clarkii				

III EXPLOITATION

1. Fishermen

Table 4. Number of fishermen

Species	1.1. Professional fishermen	1.2. Semi-professional fishermen	1.3. Subsistence and recreational fishermen
Astacus astacus	None	None	Very few, but impossible to evaluate
Astacus leptodac-tylus	None	None	None
Astacus pallipes	None	None	Impossible to evaluate, probably some thousands
Procambarus clarkii			

2. Basis for the crayfish fisheries

Table 5.

Species	1.1. Crayfish catching is free	2.2. The owner of the water area can catch crayfish	2.3. Catching area can be hired
Astacus astacus	No	Yes, if the private waters are not communicating with public waters	No, only for aquaculture rights
Astacus leptodactylus	"	"	"
Astacus pallipes	"	"	"
Procambarus clarkii			

3. Fishing methods and equipment

3.1. Legal fishing methods: with ~~rods, balances and traps;~~ balances and traps are frequently used, but ~~more often~~ illegal methods are used (hand picking, harpooning, landing-net and trammel-net, lights etc.).

3.2. National and regional regulations make no special provision for crayfish catching equipment.
In the Region Marche, balances with no more than 50 cm in diameter and mesh size 16 mm.

4. Since when has the species been exploited?

Astacus astacus and **Astacus pallipes** have been exploited since ancient times.
Astacus leptodactylus is not adequately exploited becauce it is still acclimatising.

5. Fishing seasons

5.1. For all species: from the first of July to the end of March (National law).

5.2. Some regions and provinces where crayfish is threatened have forbidden fishing for periods even of some years.

6. Fishing operations and results

6.1. No data for all species.

6.2. **Astacus astacus**: insignificant.
Astacus leptodactylus: still light, likely to grow.
Astacus pallipes: heavy in certain places.
Procambarus clarkii: no.

6.3. No data for all species.

6.4. No data for all species.

7. Changes in catches and the reasons for the changes during the last ten years or earlier

Astacus pallipes: considerably decreased in the last 15-20 years. Reasons: water pollution, man-made environmental alterations, over fishing, possibly diseases.
Astacus astacus: no data.

IV VALUE OF CATCHES AND PROCESSING

1. No data.

2. No data.

3. **Astacus pallipes**: great quantities exported in the past (especially to France) from Central Italy, at present no export.
Astacus leptodactylus: great quantities imported from Turkey every year.
Procambarus clarkii: small quantities imported from Spain and Kenya, unsuccessful due to poor handling by importers.

V PROTECTION AND MANAGEMENT

1. Regulatory measures

1.1. For all species, fishing is forbidden from 1st April to 30 June. Fishing of **Astacus pallipes** is totally forbidden in several places, at times it has been so for several years (from 1975 seems Region Liguria, from 1977 seems Lombardia etc.).

1.2. For all species, minimum legal size is 7 cm.
Seasonal protection: see III - 5.

1.3. No data.

2. Control of alteration of the environment

2.1., 2.2., 2.3. General control measures for all waters. No special provisions for crayfish.

2.4. The attempts to protect the most endangered crayfish populations (populating, transplantation etc.) have been few with insignificant results.

3. No data.

VI CRAYFISH CULTURE

1. The purpose of crayfish cultivation

Astacus pallipes and Astacus leptodactylus: the purpose is to produce material for stocking;
Procambarus clarkii: its breeding is planned only in controlled environments.

2. Methods

2.1. **Astacus pallipes and Astacus leptodactylus:** trout pellets, fish eggs, fish, earth worms, natural benthos;
Procambarus clarkii: rice, potatoes, carrots and other vegetables, trout pellets, fish, natural benthos.

2.2. They are cultivated in earthen ponds and concrete basins.

3. Intensity

3.1., 3.2., 3.3. Data not yet available.

VII PARASITES AND DISEASES

Fungal diseases: **Astacus pallipes and Astacus leptodactylus** eggs are infected by Saprolegnia sp.;
Astacus leptodactylus is sometimes infected by burned spot disease (Cephalosporium leptodactyli),
Astacus pallipes also is affected by this fungal disease, but its pathogenic agents are unknown.

NETHERLANDS

L. B. Holthuis

I SPECIES, ORIGIN, GEOGRAPHICAL DISTRIBUTION

1.-2. Nomenclature and origin of the species (Table 1)

Table 1. Scientific and common names of the species. Origin of the species and if introduced the main purpose. (Number refers to the questionnaire. For complete questions, see the questionnaire.)

1.1. Scientific name(s)	1.2. Common name(s)/ in English	2. Origin of the species
Astacus astacus	Rivierkreeft/ River crayfish	Native
Astacus leptodactylus	Eschscholtz	Imported [1]
Orconectes limosus	Gevlekte Amerikaanse rivierkreeft	Immigrated [2]
Procambarus clarkii	Rode rivierkreeft/ Red river crayfish	Imported [3]

1) The species is imported (mostly from Turkey) as gourmet-food and may have escaped. First certain find in 1977. It is possible that it has established itself in the eastern part of the country, but no firm data are available. The population is not only formed by escaped specimens; in a few localities intentionally introduced.

2) Entered Netherlands through the expansion of its ranges in Germany and Belgium (and France). Found for the first time in 1969.

3) Probably mostly animals escaped from aquaria, as this species is sold in the aquarium trade.

3. Distribution (Table 2)

Table 2. Distribution of the crayfish species in Netherlands.

Species	3.1. Geographical distribution	3.2. Description of the habitats	3.3. Determinants of distribution	3.4. Changes in distribution	3.5. Frequency in the distribution area	3.6. Hybridization
Astacus astacus	In the big rivers and small streams in Central, East and South Netherlands (see the map)	Rivers, brooks, ponds, slow flowing or stagnant waters	-	Decreaced (no firm proofs available)	-	No evidence
Astacus leptodactylus	In the Central, East and Western parts of the country	In smaller rivers, lakes and canals	-	Increasing	Sparse species, abundance increasing	No evidence
Procambarus clarkii	Found at five different localities in the Netherlands, four of these are in the most densely populated western part of the country	In canals	Canals, in which P. clarkii specimens are found, are free from ice in the winter because of heated water (for example there is one electrisity plant pumping it's cooling water in one of these "warm water" canals	Perhaps a propagating population in this artificial environment	Very sparse (?)	No evidence
Orconectes limosus	Found in nearly everywhere in the country, except near the coast	Canals, rivers, pools, slow flowing or stagnant waters	-	Increased	-	No evidence

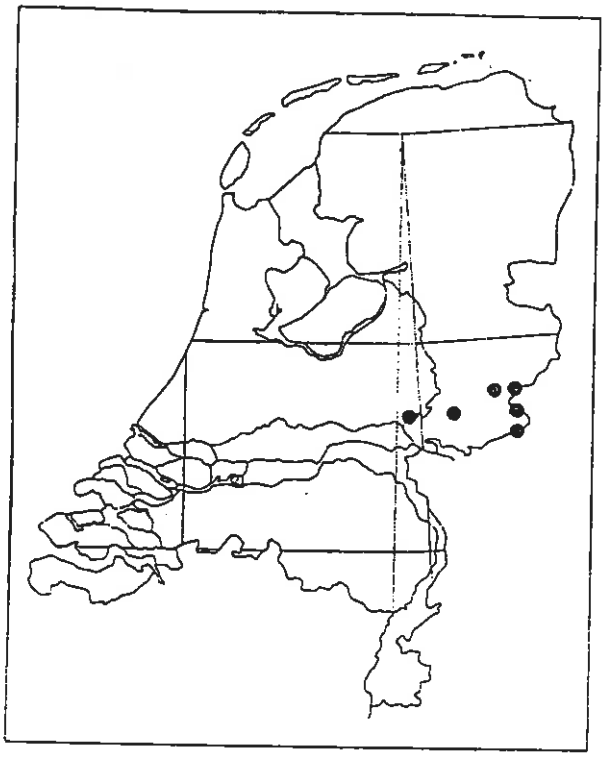


FIGURE 1. Finds of **Asatcus astacus** in the Netherlands since 1977.

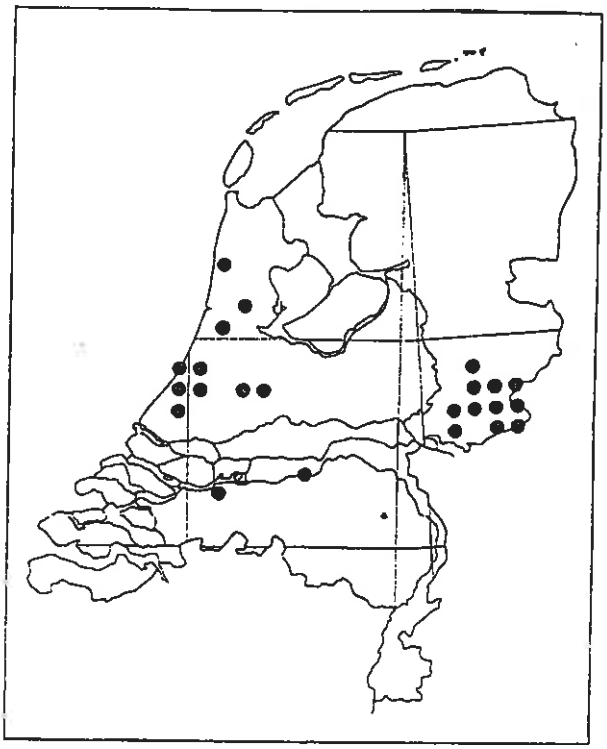


FIGURE 2. The distribution of **Astacus leptodactylus** in the Netherlands, January 1990.

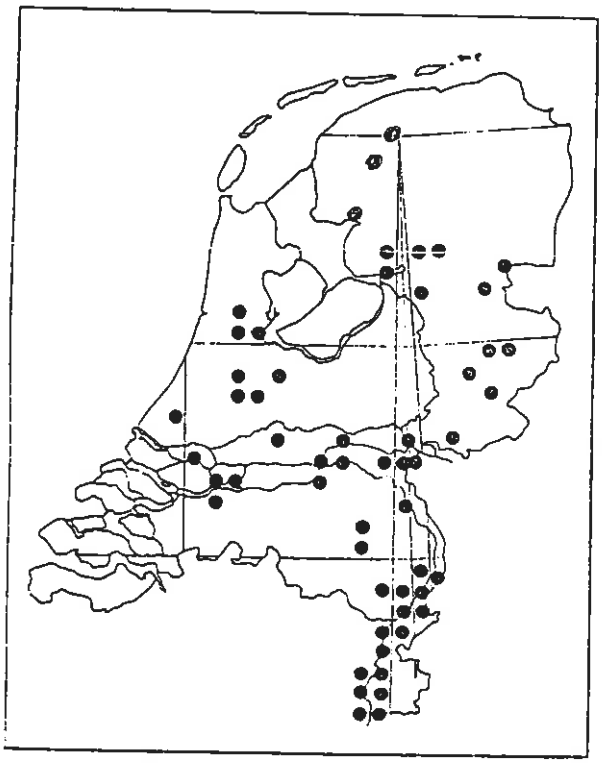


FIGURE 3. The distribution of **Orconectes limosus** in the Netherlands, January 1990.

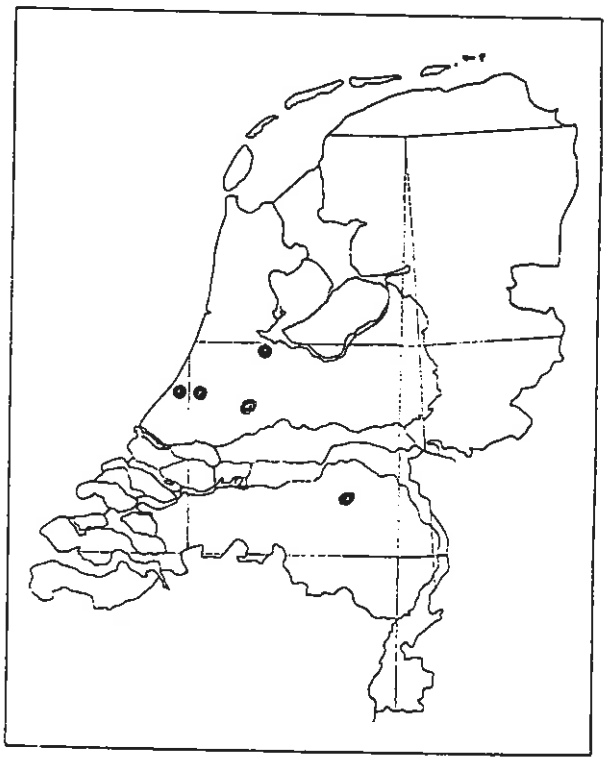


FIGURE 4. Finds of **Procambarus clarkii** in the Netherlands.

II POPULATION

1. Abundance and density of the population (Table 2)

Table 2. Abundance and density of the crayfish populations in Netherlands.

Species	1.1. Average abundance in the distribution area	1.2. Population size and density in different habitats	1.3. Changes in abundance	1.4. Reasons for changes in abundance
Astacus astacus	Sparse	No information available	Decreased	1) Changes of environmental condition: - pollution - canalizations 2) Diseases - plague
Astacus leptodactylus	Sparse	-	Increasing	
Orconectes limosus	Locally rather abundant	No information available	Increased	Expansion of the area
Procambarus clarkii	Probably sparse			

III EXPLOITATION

There has never been a crayfish fishery in Netherlands.
A crayfish may be accidentally caught, but is not especially looked for.

IV VALUE OF THE CATCHES

-

V PROTECTION AND MANAGEMENT

Since October 1973 Astacus astacus is fully protected be law.

VI CRAYFISH CULTURE

Do no exist.

VII PARASITES AND DISEASES

No information available.

VIII FURTHER INFORMATION

Astacus astacus (L., 1758); Rivierkreeft. Native. In big rivers and small streams in Central, East and South East Nerherlands. In rivers, brooks ponds, slow flowing of stagnant waters. The population has decreased. Since 1973 it is fully protected. The scarcity of records certainly is due to decrease of the populations. The protection law decreased the catches of the species and thus the records of its occurrence. On the other hand several records prove to be based on the introduced species, and others are doubtful. The enclosed map gives the catches after 1977.

Orconectes limosus (Rafinesque, 1817); Gevlekte Amerikaanse rivierkreeft. Immigrated through the expansion of its range in Germany and Belgium (and France). Found for the first time in 1969. Found in canals, rivers, pools, slow flowing or stagnant waters. Range increased; the species is known from almost the entire country, except close near the coast. Locally, it can be rather abundant.

Astacus leptodactylus Eschscholtz, 1823; Turkse Rivierkreeft. Is found in smaller rivers, lakes and canals in the cantral, east and western parts of the country. The species is imported (mostly from Turkey) as gourmet-food and may have escaped. First certain find in 1977. It is possible that it has established itself in the eastern part of the country, but no firm data are available. It evidently is still increasing in numbers. No hybridization is reported. It still is a sparse species, but its abundance seems to increase. The population is not only formed by escaped specimens; in a few localities it has been intentionally introduced.

Procambarus clarkii (Girard, 1852); Rode Rivierkreeft. This species has been found at five different localities in the Netherlands. Four of these are in the most densely populated western part of the country, one is more to the south-east. Some of these records (probably most) may pertain to animals escaped from aquaria, as they are sold in the aquarium trade. These specimens probably will be killed by the low winter temperatures. A special case is the find of one specimen in 1985, in

a canal in The Hague. This canal forms part of a system of canals in the town in which an electricity plant pumps its cooling water. The temperature of the water in there canals is thereby raised, and they are intentionally kept free from ice during the winter. When this find was published in a local newspaper, a restaurant keeper came forward and reported that in 1979 he had dumped a batch of 10 live crayfishes in the canal in front of his establishment. He had received the specimens from Kenya (thus they have to be **Procambarus clarkii**), bur he found that he could not use them. His canal forms part of those of which the water is heated and is not far from the one in which the 1985 specimen was found. The latter can not be one of those discarded in 1979, as the species lives at the most 3 years. There could be a possibility that the 1979 animals propagated and that the one found in 1985 is an offspring of the fourth of fifth generation. This is the more likely as recently there have been reports that the species still occurs in those canals. I have not seen any of these recent ones myself, but the reports came from reliable observers. There is thus a possibility that a propagating population exists in this artificial environment.

NORWAY
E. Dehli, T. Qvenild, T. Taugböl, J. Skurdal

I SPECIES, ORIGIN, GEOGRAPHICAL DISTRIBUTION

1.-2. Nomenclature and origin of the species (Table 1)

Table 1. Scientific and common names of the species. Origin of the species and if introduced, the main purpose (Number refers to the questionnaire. For complete questions, see the questionnaire.)

1.1. Scientific name(s)	1.2. Common name(s)/ in English	2. Origin of the species
Astacus astacus	Kreps/crayfish	Immigrated or introduced from Sweden in the last 200 - 300 years. First described in litterature 1752.

3. Distribution (Table 2)

Table 2. Distribution of the crayfish in Norway.

Species	3.1. Geographical distribution	3.2. Description of the habitats	3.3. Determinants of distribution	3.4. Changes in distribution	3.5. Frequency in the distribution area (% of waters)	3.6. Hybridization
Astacus astacus	In South-East Norway. Vestfold, Buskerud, Østfold, Oslo/Akershus, Hedmark and Oppland countries. Isolated populations in Western and Middle parts of Norway	- In shallow lakes with a limecontet > 2-3 mg Ca/l - also in some great, deep lakes and small humic lakes which have rocky shores - Many of the rivers are good crayfish habitats	- mainly the ([1] water quality and the tempeture - in some coastal waters predation by eel -crayfish plague	Populations ([2] in the Glomma and Halden River system lost in 1987-89 due to crayfish plague	-	-

1) Lakes and rivers poor in salt content (<15-20µS/cm) and with acidic water (pH <5.5-6.0) seem to be unsuitable for crayfish. Few populations in altitudes of 400-500 m a.s.l. or more.

2) Changes in distribution is mainly a result of stocking success and crayfish plague.

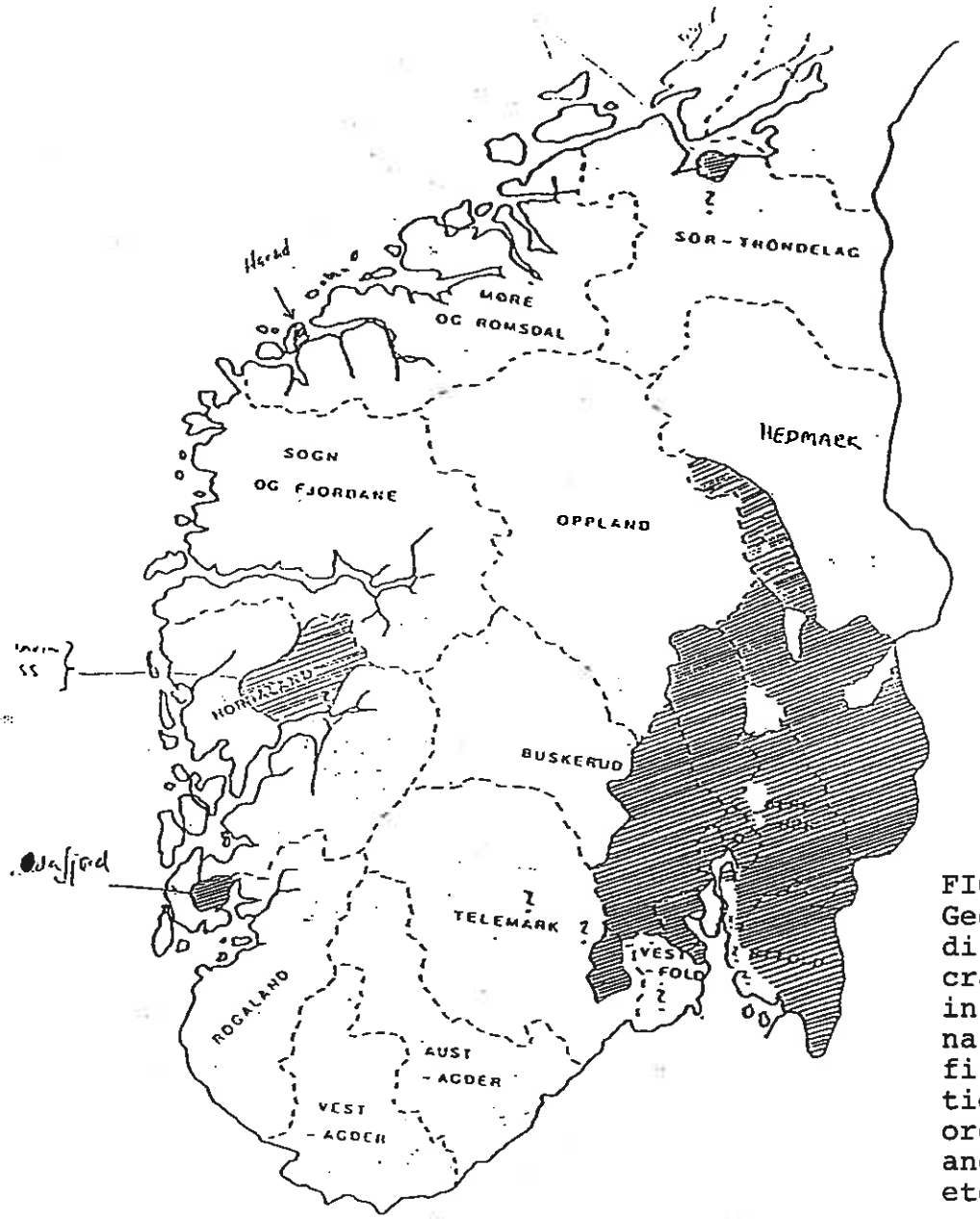


FIGURE 1. Geographical distribution of crayfish in Norway in 1979. (Questionnaire to the county fishery administrations, land owner organizations, anglingorganizations etc.)

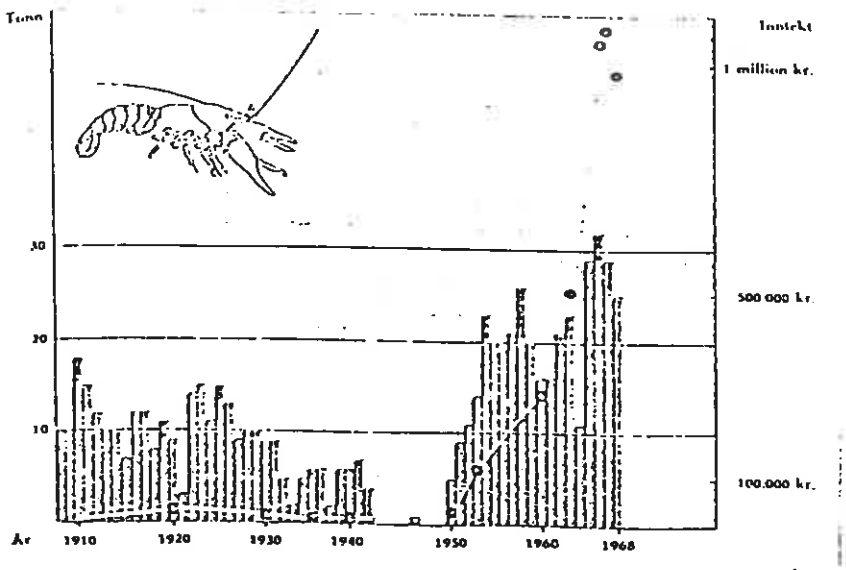


FIGURE 2. The export of crayfish to Sweden (the dots give the value in Norwegian crowns).

II POPULATION

1. Abundance and density of the population (Table 3)

Table 3. Abundance and density of crayfish population in Norway.

Species	1.1. Average abundance in the distribution area	1.2. Population size and density in different habitats	1.3. Changes in abundance	1.4. Reasons for the changes
Astacus astacus	Fairly abundant	- In shallow great lakes dense (Lake Steinfjorden 13-36 indiv.> 70 mm total length /100 m^2) - in great deep lakes very sparse - in many rivers dense	-	-

III EXPLOITATION

1. Fishermen

Table 4. Number of fishermen

1.1. Professional	1.2. Semi-professional	1.3. Subsistence and recreational
0	about 10 - 15	There is no statistics available for the whole country. A rough estimate is 10 000-15 000.

2. Basis for the crayfish fisheries

Table 5. Basis for the crayfish fisheries

2.1. Catching is free	2.2. The owner of the water area can catch	2.3. Catching areas can be hired
In Lake Steinsfjorden In river Glomma (1	In the greatest (2 part of the area	In Oslomarka and Kongsvinger

1) In River Glomma the plague wiped out the crayfish population in 1987. A restocking program is started.

2) In some areas catching is strictly controlled (Nordmarka north of Oslo) but in other areas (e.g. Lake Storsjøen) fishing is allowed to a extent.

3. Fishing methods and equipment

3.1. Semi-professional fishermen use only baited traps. Generally the main methods in recreational fishing are picking by hand or with some equipment and a limited usage of traps.

3.2. The most used traps are the Steinfjord-traps. The trap is 20 cm high with one funnel entrance and the bottom diameter is 30 cm. The legal mesh size is 21 mm.

4. Since when has the species been exploited?

Export statistics are available since 1908.

5. Fishing seasons

Open 06.08. at 6.00 P.M. - 15.09.
From 1981 the opening of the season is 6th of August at 6 P.M. (18.00) and the close at 14th of September. From 1989 on, the season in L. Steinsfjorden close at 28 - 29 August. Fishing is at its maximum at the beginning of the fishing season and gradually declines.
In Lake Steinsfjorden about 10 000 traps are used in the first night. In 3 weeks this gradually declines to about

1 000 when a new maxima occurs with about 2 000 - 4 000 traps.

6. Fishing operations and results

Table 6. Catches per unit fishing effort, degree of exploitation, catch statistics and total annual catch of crayfish, **Astacus astacus**, in Norway (see the complete questions III 6.1.-6.4. on the questionnaire).

6.1. Catch per unit fishing effort	6.2. Degree of exploitation	6.3. Catch statistic available	6.4. Total annual catch
In Lake Steinsfjorden 1977-1988: 0.8-1.37 crayfish/trap (25 catching days) (1	In the whole country moderate. In Lake Steinsfjord heavy (2	- For the whole country trade statistics are available since 1908. - Catch statistics from Lake Steinsfjorden in 1979-1988: 3 250 - 6 400 kg	20 - 40 tn

1) Based on catches from 350 - 630 traps placed over the entire area.

2) In 10 fishing days 50 % of the catchable part of the population is caught. Totally about 70 - 90 % of crayfish > 9 cm is taken (The size of the population has been estimated by the successive removal method of Leslie.).

7. Changes in catches

The variablity in the catches in Lake Steinsfjorden is mainly due to the heavy exploitation and until now only to a small extent due to the invasion of waterweed (**Elodea canadiensis**).

IV VALUE OF CATCHES AND PROCESSING

Table 7. Value, use and foreign trade of crayfish in Norway.

Species	1. Value of catches	2. Use of catch		3. Foreign trade	
		fishermen's own use	for sale	import	export
Astacus astacus	Firsthand price 1989: NOK 150-200/kg For the whole country < 5 mill.NOK	yes	yes1)		- 1968 - 20 tn/year - 1980 10-15 tn/year(2

1) All the semi-professional fishermen sell their catch.

2) In the last years most crayfish is consumed in Norway.

V PROTECTION AND MANAGEMENT

1. Regulatory measures

1.1. In some organized areas (Oslomarka) there is a limitation on trap numbers per fisherman, i.e. 5 trap per fisherman. Otherwise no such restrictions are known.

1.2. In 1981 the new legislation was:
- fishing season 6.8.-15.9.,
- size limit ≥ 9,5 cm total length,
- mesh size of traps (knot to knot) ≥ 21 mm

2. Control or alteration of the environment

2.2. Liming is an important method in many Norwegian lakes to improve the water quality in the crayfish area. Until now this has been done only to a little extent.
Water pollution control for sanitary reasons has improved the conditions in many small watershed but nothing has been done especially for the crayfish.

2.3. Stocking is only used for transplantation of crayfish to new localities and not for maintenance of crayfish populations.

VI CRAYFISH CULTURE

1. The purpose of crayfish cultivation

The purpose is to produce stocking material and crayfish for consumption.
By November 1987, the authorities had given 4 crayfish culture licenses and 21 applications were for evaluation. Most applications are for intensive culture of grayfish for consumption.
In 1989 a lisence was given for aquaculture with the Australian species Red claw crayfish.

2. Methods

Crayfish culture methods include both extensive, semi-intensive and intensive culture systems. As yet, no one has succeeded in

making crayfish culture in Norway profitable.

3. Intensity

About 250 000 juveniles and 5 tons of crayfish for consumption (9,5 - 10 cm) are planned to be produced annually.

VII PARASITES AND DISEASES

Fungal diseases
Crayfish plague (**Aphanomyces astaci**)

1. Crayfish species

Astacus astacus

2. Origin of the disease

It has propagated from Sweden in 1971-1973 probably with transplantation of infected specimens.

3 Distribution

The plague is registrated only in two rivers (Vrangselva and Veksa) near the Swedish border.

4. Significance

The infection was total and the whole population was eradicated.

5. Preventive measures and treatment

5.1. For transplantation veterinary certificate is requested. Fishing equipments used in other watercourses must be desinfected.

5.2. No chemical treatments to prevent plague was tried.

5.3. Electrical barriers was tried in Vrangselva without succes. Moving the electrical barrier upstream was also without succes. The plague was stopped by a barrage.

Protozoan diseases

The porcelain disease (**Thelohania contejeani**) is registered in Lake Steinsfjorden with a population infection intensity up to 3 %.

Crayfish plague

Crayfish plague deteriorated the crayfish population in the Veksa and Vrangselva watercourse, south of Kongsvinger, in 1971-1974. In 1987 the plague stroke in River Glomma and in 1989 in the Halden watercourse. Thus, two of the best crayfish localities in Norway were damaged. However, a restocking program is started, and the first reintroduction of Crayfish in River Glomma after the plague outbreak occurred in 1989.

POLAND

J. Kossakowski

I SPECIES, ORIGIN, GEOGRAPHICAL DISTRIBUTION

1.-2. Nomenclature and origin of the species (Table 1)

Table 1. Scientific and common names of species. Origin of the species and if introduced the main purpose. (Number refers to the questionnaire. For complete questions, see the questionnaire.)

1.1. Scientific name(s)	1.2. Common name(s)/ in English	2. Origin of the species
Astacus astacus	Rak szlachetny/"noble" crayfish rak szerokoszczypcy/ broad-pincered crayfish	Native
Astacus leptodactylus	Rak błotny/swamp crayfish rak stawowy/pond crayfish rak wasko-lub długoszczypcy/ narrow- or longpincered crayfish	Introduced from Russia at the beginning of this century (1
Orconectes limosus = Cambarus affinis	Rak pregowaty/"striped" crayfish Rak amerykanski/ American crayfish	Introduced from Germany at about 1890

1) It was belived that A. leptodactylus was resistant to crayfish plague and therefore it was introduced to compensate A. astacus which was nearly totally destroyed by crayfish plague.

3. Distribution (Table 2)

Table 2. Distribution of the crayfish species in Poland.

Species	3.1. Geographical dustrubution	3.2. Description of the habitats	3.3. Determinants of distribution	3.4. Changes in distribution	3.5. Frequency in the distribution area (% of waters)	3.6. Hybridization
Astacus astacus	All over the country	Brooks, rivers, lakes, bogs, quarry lakes Inhabits shore areas to the depth of the occurrence of submerged vegetation	1) Changes of environmental conditions - regulation of rivers - amelioration works water pollution 2) Crayfish diseases 3) Predation, esp. by eel and to a smaller extend by perch	No data available	No data for the whole country (roughly estimate 0-25 %) - accidental information: Great Poland region ~ 5 %, region of Lublin < 0,5 %, Suwalxi Lakeland 25 %	Not noted
Astacus lepto-dactylus	Occuring all over the country, but more "regionally" than A. astacus	Lakes, natural ponds, bogs, quarry lakes, various water bodies, rivers and streams	1) Changes of environmental condition: - lowering of water level in reservoirs results to winter kills 2) Disease 3) Predation by eel and perch	No data available	No data for the whole country (roughly estimate 0-25 %) - accidental information: Great Poland region ~ 15 %, region of Lublin ~ 22% Suwalki Lakeland; only in one lake	Not noted
Orconectes limosus	Nearly all over the country (see the map)	All types of water bodies and flowering waters. Especially rivers, canals, dam reservoirs, ponds, lakes. Inhabits the shore areas of the large reservoirs and upon the whole bottom area of shallow water bodies	1) Changes of environmental condition: - water pollution 2) Predation by eel (to a smaller extent)	Extended	In Western Poland 50-75 %, in central and eastern Poland 0-25 %	Not noted

OCCURENCE OF CRAYFISH ORCONECTES LIMOSUS IN POLAND

The range of occurence to the east:

---------- 1953- according to the data of the Inland Fisheries Institute, Olsztyn

.... 1959- according to the data of Institute of Nature Protection, of the Polish Academy of Sciences, Kraków

-.-.-.-.-.-.- 1980- most probably current range

II POPULATION

1. Abundance and density of the population (Table 3)

Table 3. Abundance and density of the crayfish populations in Poland.

Species	1.1. Average abundance in the distribution area(1	1.2. Population size and density in different habitats	1.3. Changes in abundance	1.4. Reasons for the changes
Astacus astacus	Scarce	Accidental information: - streams: 0.1 indiv./km (2 - lakes: 5 indiv./ha - bogs and quarry lakes: 10 indiv./ha <0.1 indiv./m(3	No detailed data available	- Diseases - water pollution - predation
Astacus leptodactylus	Scarce	No data for the whole country. Accidental information: - streams: 4 indiv./km(2 - lakes-5 indiv./ha - bogs and quarry lakes: 15 indiv./ha fairly dense(4	- " -	- " -
Orconectes limosus	Fairly dence	No data for the whole country Accidental information: - rivers: 10 indiv./km(2 - lakes: 15 indiv./ha - bogs and quarry lakes: 20 indiv./ha	- " -	No data available

1) No detail data for the country available but only the estimates
2) Great Poland Region
3) Region of Western Pomerania, lakes Skotawako Wielkie and Skotawsko Male
4) Region of Lublin

III EXPLOITATION

1. Fishermen

Table 4. The number of professional, semi-professional and subsistence and recreational fishermen in Poland.

Species	1.1. Professional fishermen	1.2. Semi-professional fishermen	1.3. Subsistence and recreational fishermen
Astacus astacus	0 (1	No data for the whole country. Accidental information Lublin: 1961-1965: 34-45 1966-1977: 8-15 (3	No quantitative data available. Accidental information from the region near Lublin: 1970-1977 about 100 (2
Astacus leptodactylus	0 (1	No data for the whole country. Accidental information from the region near Lublin: 1965: ~ 10 1977: ~ 4 (3	No quantitative data available. Accidental information from the region near Lublin: 1970-1977 about 100 (2
Orconectes limosus	0	0	No quantitative data available (it is howewer estimated that the number is high)

1) A personal estimate of respondent. No detail data available.
2) They are people which fished crayfish legally but it is known that il legal crayfish catches do occur.
3) Number of fishermen in 1987 (A. astacus and A. leptodactylus compined): about 30.

2. Basis for the crayfish fisheries

Table 5. Basis for the crayfish fisheries.

Species	2.1. Catching is free	2.2. The owner of water area can catch crayfish	2.3. Catching areas can be hired
Astacus astacus	For the members of the Polish Anglers Association in the waters utilized by The Association and by State Fish Farms	Yes (1	Yes - from the private owners of the waters
Astacus leptodac-tylus	"	Yes (1	"
Orconectes limosus	Yes	Yes	Not significant for thie species

1) Fish refers to State Fish Farms, Fishery Cooperatives and private owners of waters.

3. Fishing methods and equipment

3.1. **Astacus astacus and Astacus leptodactylus:**

- Commercial catches (professional catches) have been carried out practically exclusively with crayfish traps, called "bucz".
- Anglers (recreational) catches are made with so-called balances.

Fish is usually used as a bait, sometimes also frogs are used.

Orconectes limosus:

There are no methods for catching commercialy.

Catches made with traps are accidental.

Most frequently this species is caught manually, over the bottom, under stones etc. by accidental fishermen.

3.2. A typical crayfish trap is a basket made of redwood or spruce strips, cylinder-shaped, with throats on either end, tapering inward and representing the entrance to the trap.

It is used for catching on a commecial scale and it represent a typical passive equipment.

Another implement used for catching crayfish is so called balance - a circular net. It is an active catching device, comparable to a lift net for landing fish, consisting of a hoop made of thick rustproof wire or of wicker, to which is attached a fine-meshed fishnet twine. The balance spreads out 40 cm in diameter while the fishnet twine should hang down loosely, baglike, to a depth of 25 cm.

4. Since when has the species been exploited?

Astacus astacus has been exploited in Poland since hundreds of years. Since 1980 no commercial crayfish catches are obtained.

Astacus leptodactylus: Exploitation of this species on a commercial scale within the existing borders of Poland dates back up to 1945.
About 1980 commercial catches for this species practically ceased.

5. Fishing seasons

5.1. **Astacus astacus and Astacus leptodactylus:**
Fishing seasons - males 16.3.-14.10.
females 1.8.-14.10

Intensive exploitation usually starts in May, with peak in August - September.

Orconectes limosus: Fishing season does not exist.

5.2. Duration of the season varies considerably depending mainly on weather conditions, i.e. on water temperature and the resulting intensive grazing of crayfishes.

6. Fishing operations and results

Table 6. Catches per unit fishing effort, degree of exploitation, catch statistics and total annual catch of crayfish in Poland.

Species	6.1. Catch per unit fishing effort	6.2. Degree of exploitation	6.3. Catch statistics available	6.4. Total annual catch
Astacus astacus	No data available	Considerable exploitation	-Up to 1977-78 there were catch statistics giving total catch of crayfish. -There might be statistics on foreign trade but these are hardly available. -Data of total catches in Poland have been supplied to FAO fishery statistics	1949-1958:([1] 49 metric tn 1959-1968: 45 metric tn 1969-1978: 15 metric tn A. astacus: 1986: 2700 kg 1987: 3450 kg A. leptodactylus: 1986: 700 kg 1987: 1700 kg
Astacus leptodactylus	"	"		
Orconectes limosus	Does not exist	Does not exist	In fishery statistics, until 1978, it was possible to find accidental and incomplete data	Does not exist

1) The two species (A. astacus and A. leptodactylus) are combined

7. Changes in catches

Changes in catches in the recent years were caused by several factors: first of all, significant decrease of crayfish stocks of Poland, secondly crayfish catches with traps became unprofitable for professional fishermen compared to fish catches, especially in case of waters with high eel stocks.

IV VALUE OF CATCHES AND PROCESSING

Table 7. Value, use and foreign trade of the crayfish catches in Poland.

Species	1. Value of catches	2. Use of catch fisherman's own use	for sale	3. Foreign trade import	export
Astacus astacus	At present no economic value in the fishery statistics price: 1987 = 400-800 Polish zloty/kg	Yes(1	yes (to the national market net)	no	Untill 1978 practi-cally all 1986: 2650 kg 1987: 2850 kg
Astacus leptodac-tylus	Price: 1987= 400-800 Polish zloty/kg	Yes(1	"	no	1986: 680 kg 1987: 1700 kg
Orconectes limosus	-	Negligible	no	no	no

1) Anglers' (recreational) catches are only for their own use.

V PROTECTION AND MANAGEMENT

1. Regulatory measures

1.1. **Astacus astacus and Astacus leptodactylus:**
In case of recreational catches there is a limit of fishing gear to be used by one angler; i.e. up to 5 balance.

Orconectes limosus: Do not exist.

1.2. Protection of population
Astacus astacus and Astacus leptodactylus:
Size limitation: They can be caught at body size > 9 cm
Seasonal protection: males 15. Oct. - 15. March
females 15. Oct. - 31. August
Fishing for females which are bearing eggs (for their transplantation to other waters) requires additional permission.

Orconectes limosus: Not applied.

2. Control or alteration of the environment

2.1.-2.2. Physical and chemical features.
No control.

2.3. Biological features
Disease control and prophylactic measures - according to the needs stated by water user - are undertaken by state veterinary service.

2.4. Stocking
A. astacus and A. leptodactylus:
Sporadically, on a limited scale adult males or females bearing eggs were transferred to other water bodies in order to strengthen their native crayfish stocks. Effects of these sporadic measures are not known.

VI CRAYFISH CULTURE

1. The purpose of crayfish cultivation

A. astacus and A. leptdactylus:
Scope of these, always sporadic, attempts was the production of stocking materials.
O. limosus: Do not exist.

2. Methods

3. Intensity

VII PARASITES AND DISEASES

Virus diseases: -
Bacterial diseases: -
Fungal diseases:
Crayfish plague / **Aphanomyces astaci:**
The two crayfish species, Astacus astacus and Astacus leptodactylus, are infected by the plague.

It is very difficult to estimate the distribution, intensity and frequency of occurence of the plague. No studies

are carried out in this respect and there are no statistics available. Significant or total extinction of crayfishes from particular water bodies ascribed to the occurence of crayfish plague is usually started post factum and with no veterinary service present. Generally there are no data of this subject.

Burned spot disease:

Detail information obtained from the region of Mazurian Lakeland. This disease is diagnosied every 2-3 years in crayfishes (**Astacus leptodactylus**) from waters near Ostróda with extensiveness of 40-50 % and varying degree on intensity.

Protozoan diseases

White tail desease / **Thelohania contejeani**:
This disease occurs sporadically in **A. astacus** populations and usually does not result in mass kills.
Detail informations obtained from the region of Mazurian Lakeland, source of Drweca Riverk: Around 1970 the disease was noted in two successive uears (in **A. leptodactylus** populations) with the extensiveness of about 7 % and high intensity.

Psorospermium haeckeli:

Parasites occurs near Ostróda, Mazurian Lakeland, almost every year (in **A. leptodactylus** populations). Extensiveness of 60-85 %, intensity from slight to significant. For the whole country it is, howewer, a sporadic disease and does not lead to crayfish kills. There are no detail data.

Helminths

Branchiobdella sp.
No data for the whole country available. According to the detail information parasite occurs in crayfishes near Ostróda, Mazurian Lakeland, and at sources of Drweca River. Noted every 2-3 years, only upon the carapace (**B. parasita** Henle; **B. pentadonta** Whitman). Intensity from slight to average.

Other diseases

No data of their occutrence in Polish waters.

PORTUGAL

Fausto S. Reis

I SPECIES, ORIGIN, GEOGRAPHICAL DISTRIBUTION

1.-2. Nomenclature and origin of the species (Table 1.)

Table 1. Scientific and common names of the species. Origin of the species and if introduced the main purpose. (Number refers to the questionnaire. For complete questions, see the questionnaire.)

1.1. Scientific name(s)	1.2. Common name(s)/ in English	2. Origin of the species
Austropotamobius pallipes	Lagostim de pés brancos	Immigrated from Spain
Procambarus clarkii	Lagostim vermelho	

Procambarus clarkii was detected in the River Guadiana (South of Portugal) in 1981, **Procambarus** spread from Spain. After having colonized nearly all the basins of Guadiana (river, brooks and lake dams), it occupies now also some tributaries of the River Tejo and other rivers.

The main population of **Austropotamobius pallipes** in the northern part of the country has disappeared probably due to the plague spread by **Procambarus clarkii**.

III EXPLOITATION

1. Fishermen

Crayfish are caught in Portugal only by sports-men, A. pallipes are fished mainly by Spanish in the north frontier. Crayfish are caught in their natural habitat.

6. Fishing operations and results

Table 6. Total annual catch

Species	Specimens	kg
Astacus pallipes	10 000	> 1 000
Procambarus clarkii	50 000	> 5 000

IV VALUE OF CATCHES AND PROCESSING

Table 7. Value, use and foreign trade of the crayfish catches in Portugal.

Species	1. Value of catches	2. Use of catch	3. Foreign trade
Astacus pallipes	1986: 5-10 US$/kg (5 000-10 000 US$)		There is no crayfish export or import in Portugal
Procambarus clarkii	1986: 2-3 US$/kg (10 000- 15 000 US$)		

VI CRAYFISH CULTURE

There are no crayfish farms in Portugal at the moment.

VII PARASITES AND DISEASES

Fungal diseases: Crayfish plague/
Aphanomyces astaci

The main population of **A. pallipes** in the northern part of the country has disappeared probably due to the plague.

VIII FURTER INFORMATION

Some studies on **P. clarkii**, mainly concerning rearing methods, have been initiated at the "Posto Aquicola de Azambuja", Forest General Direction, near Lisbon. The technicians of the General Direction have also followed the evolution of the natural populations of **P. clarkii**. Trials have been planned to study its association with different fish species, as well as its production in rice fields.

SPAIN

A. S. Habsburgo-Lorena

I SPECIES, ORIGIN, GEOGRAPHICAL DISTRIBUTION

1. Nomenclature and origin of the species (Table 1)

Table 1. Scientific and common names of the species. Origin of the species and if introduced the main purpose. (Number refers to the questionnaire. For complete questions, see the questionnaire).

1.1. Scientific name(s)	1.2. Common name(s)/ in English	2. Origin of the species
Astacus pallipes pallipes	Cangrejo de rio / Cangrejo Autoctono/ River crayfish	Native
Pacifastacus leniusculus	Cangrejo senjal / Signal crayfish	From Sweden 1974, for restocking plague depleted rivers
Astacus leptodactylus	Cangrejo turco / Turkish crayfish	From Turkey 1975, for commercial purpose
Procambarus clarkii	Cangrejo de les marismas / Red crayfish	From USA 1974, to protect native species from over-fishing

3. Distribution (Table 2)

Table 2. Distribution of the crayfish species in Spain.

Species	3.1. Geographical distribution	3.2. Description of the habitats	3.3. Determinants of distribution	3.4. Changes in distribution areas	3.5. Frequence in the distribution area (% of waters)	3.6. Hybridization
Astacus pallipes pallipes		Cold, shallow, slow, flowing waters: rivers, power stations, brooks in mountain areas	Water quality, temperature, substrate. Limitation factors; pollution, diseases, overfishing, drought, riverregulation, conversion of natural irrigation, chanels into concrete canals	Sharp decrease (see chapter IV)		Not observed
Pacifastacus leniusculus		Cold waters; basins, raceways and one brook	Water quality, temperature, substrate, light	Slow increase		"
Astacus lepto-dactylus		Cold waters, basins	- " -	Disappeared		"
Procambarus clarkii		Warm waters; paddy fields, slow flowing waters	Water quality, substrate, salinity, water depth, subaquatic level	Sharp increase		

II POPULATION

1. Abundance and density of the population (Table 3)

Table 3. Abundance and density of the crayfish populations.

Species	1.1. Average abundance	1.2. Population size and density	1.3. Changes in abundance	1.4. Reasons for the changes
Astacus pallipes pallipes	There are areas of sparse and dense abundance	Scarce	Slow decrease (see chapter IV, Table 6)	Water pollution, over fishing, river regulation, diseases
Pacifastacus leniusculus	-	< 1 crayfish/m^2 - only in centers	-	-
Procambarus clarkii	Abundant	1-5 crayfish/m^2	Sharp increase (see Table 6)	-

III EXPLOITATION

1. Fishermen (Table 4)

Table 4. Number of professional, semi-professional, household and recreational fishermen in Spain.

Species	1.1.Professional	1.2.Semi-proffessional	1.3.Household and recreational
Astacus pallipes pallipes	1980: 80	1980: 10 000	1980: 900 000
Procambarus clarkii	1980: 320 1987: 655	1980: 1 000 1987: 3 100	1980:15 000

2. Basis for the crayfish fisheries (Table 5)

Table 5. Basis for the crayfish fisheries.

2.1.Catching is free	2.2.The owner of the water can fish	2.3.Catching areas can be hired	2.4.Other basis
no (1	yes (2	no	Fishing licence is needed

1) after obtaining fishing licence, crayfish fishing is free
2) only the owner of private waters can fish his own crayfish; 99.99 % of Spanish Continental waters are public.

3. Fishing methods and equipment

3.1. **A. pallipes pallipes** is caught with balances with bait.
P. clarkii is caught with funnel net traps without bait.

3.2. Netbalances; ø 20 - 30 cm
Funnel net traps: 2 m long, 3 cm meshsize

4. Since when the species been exploited?

A. pallipes pallipes: ancient times
P. clarkii: since 1976

5. Fishing seasons

A. pallipes pallipes: 21.6. - 31.8.
P. clarkii: All the year round (1

1) Fishing is at its maximum from the end of April to the middle of May and second half of September.

6. Fishing operations and results (Table 6)

7. Changes in catches and the reasons for the changes during the last ten year and/or earlier (Table 6)

Table 6. Catches per unit fishing effort, degree of exploitation, catch statistics and total annual catch of crayfish in Spain.

Species	6.1. Catch per unit fishing effort	6.2. Degree of exploitation	6.3. Catch statistic available	6.4. Total annual catch	7. Changes in catches during the last 10 years
Astacus pallipes pallipes	3-10 crayfish / balance	Heavy	1978: 643.7 tn ([1] 1979: 519 tn 1980: 200 tn 1986: 3 tn	1974: 27.6 mill.crayf. 1975: 34.1 - " - 1976: 27.0 - " - 1977: 25.1 - " - 1978: 20.8 - " -	Decreased ([2]
Procambarus clarkii	3-30 kg/day/trap ([4]	Heavy	1976: 0.8 tn 1977: 4 tn 1978: 80 tn 1979: 251 tn 1980: 350 tn 1986: 3 384 tn 1987: 4 650 tn	1986: 130.0 - " - ([5]	Increased ([3]

1) statistics of the Ministry of Agriculture

2) crayfish fishermen left their work due to vanishing population and legal catch restrictions

3) eel fishermen changed from eel fishing to crayfish fishing

4) a poor fisherman has 30 traps a rich one 200

5) catches in 1974-1978, mainly A. pallipes, in 1986 nearly all P. clarkii

IV VALUE OF CATCHES AND PROCESSING

Table 7. Value, use and foreign trade of crayfish catch in Spain.

Species	1. Value of catches	2. Use of catches		3. Foreign trade	
		fisherman's own use	for sale	imports	exports
Astacus pallipes	1975 US $ 5 177 828,-	20 %	80 %		
pallipes	1976 " 5 743 128,-				
	1977 " 6 630 871,-				
	1978 " 6 413 214,-				
	1986 " 57 000,-				
Procambarus clarkii	In origin US $ 3.12/kg	1 %	99 %		
	dealer " 5.38/kg				
	consumer 12.80/kg				
	1979: US $ 3 212 800,-				
	1980: " 3 840 000,- (1				
	1986: " 17 000 000,- (1				1986: 70000 kg (deepfrozen) 120 000 kg (live)
	1987: " 23 000 000,- (1				

1) estimated

V PROTECTION AND MANAGEMENT

1. Regulatory measures

1.1. **A. pallipes pallipes:**
Fishing allowed only on Thursday, Saturday and festive.
One can fish 80 crayfish per day. One fisherman is able to put only 8 traps per 100 m/l.
Size limit: minimum 8 cm long (from eye to telson).

Procambarus clarkii:
Size limit: minimum 5 cm.

1.2. Catching of **A. pallipes pallipes** was forbidden in ten of the 33 crayfish provinces in the year 1980.

2. Control or alteration of the environment

2.1. Physical features.
The law of fishing forbids the alteration of the river bed.

2.2. - 2.3. Chemical and biological features

No control.

2.4. Stocking

A. pallipes pallipes and **P. clarkii**: transplantation.

P. leniusculus: introduction and transplantation.

VI CRAYFISH CULTURE

1. The purpose of crayfish cultivation

The purpose of **A. pallipes pallipes** cultivation is the maintenance of stocks and to provide stocking material. **P. clarkii** is cultivated for commersial purposes and **P. leniusculus** for the production of stocking material.

2. Methods

A. pallipes pallipes and **P. clarkii** are cultivated in ponds, basins and raceways. They are fed and helped during the eclosion.

3. Intensity

There are two cultivation establishments for both species. Three establishments are State owned and one is private. The cultivation area is less than 5 000 m^2.

VII PARASITES AND DISEASES

Fungal diseases:

Aphanomyces astaci

Ramularia astaci

There are no data of the origin of the diseases and their distribution.

Individual infections are said to be intense and population infections heavy. The diseases have an important signification to crayfish culture.

SWEDEN

Magnus Fürst

I SPECIES, ORIGIN, GEOGRAPHICAL DISTRIBUTION

1.1. **Astacus astacus** LINNE

1.2. Flodkräfta, river crayfish

2.1. Native

3.1. Distributed within about 40 per cent of the total area of Sweden. Only in the southern part and the Baltic coast area.

3.2. Lakes, ponds, rivers and brooks.

3.3. Clima restricts distribution but in several running waters populations are found far above the climatic limitation for lake distribution.

The bottom substrata must be firm and have enough shelters e.g. stones, roots, logs. Depth distribution is mainly depending on substrata and temperature. Swedish lakes mainly have suitable bottoms for crayfish within the littoral zone and have soft sediment bottoms deeper. Occasionally scarse populations are found down to 60 m depth where the bottom is stony. Eel (**Anguilla anguilla**) predation decrease crayfish production especially on the West coast where elvers have access to most rivers. Crayfish plague (**Aphanomyces astaci**) has reduced the number of productive crayfish waters to 5-10 per cent. Oxygen problems are often reduced in lakes by better purification efforts. Acidification is a growing problem and has already eradicated crayfish populations in hundreds of lakes.

Exploitation has never reduced the number of crayfish but increased it and caused a reduction in mean weight.

3.4. The plague still reduces crayfish populations. Acidification is today the most important environmental problem. The migration of eel has decreased along the swedish coast and the bases for an increased crayfish production has become better. Introduction of Pacifastacus makes the restoring of Astacus populations in the same water definitely impossible.

3.5. Frequency in the distribution area is today 0-25 per cent of waters.

3.6. No hybrids between Astacus and Pacifastacus are found.

II POPULATION

1.1. The average abundance of Astacus is sparse in the distribution area.

1.2. No estimate of density is available. The average production of Astacus is about 5 kg per hectare. A highest registered average yield of 25 kg per hectare of the total surface area is reported from a mesotrophic lake. The yield of suitable habitats is 100 kg/ha in the same lake.

1.3. See I 3.4.

1.4. See I 3.4.

III EXPLOITATION

1.1. Less than 5.

1.2. Less than 100.

1.3. No statistics available. Estimated number 3-5 000.

2.1. Crayfish catching is not free. Minimum legal size is 9 cm.

2.2. The owner of the water can catch crayfish. The owner is a private person or a joint property, a company or the Swedish government.

2.3. Catching areas can be hired from the owner.

2.4. It is common to buy a fishing licence valid for one or several nights and sometimes permitting the use of a certain number of traps on a fixed part of the shoreline.

3.1.-3.2. The only used catching method is trapping. Fishing with rod and line is seldom used. Most common is a cylindrical trap with two entrances. Funnel traps or small flat nets are less used. Baits of fish e.g. roach, bream or sisco are used.

4. Astacus has been exploited as food since at least 1562. It is documented in a letter written by the king Erik XIV. Since 1700 an interest for crayfish among common people started to grow.

5.1. Fishing season started until 1990 on the second Wednesday in August and ended on October 31. Fishing is free from 1990. The peak of the catch is mostly during August.

5.2. The peak of the fishing season is later in the northern part of the country.

6.1. Catch per unit effort means the catch in one trap during one night and one emptying. The method is inexact because some crayfish escape before emptying. New escape free traps are under construction. The mean catch per effort in numbers varies very much:

15 - 25 in very good lakes
5 - 10 in good lakes
2 - 5 in avarage lakes

6.2. Stocks are mostly heavy exploited. To keep up the mean length restrictions in fishery may be stated.

6.3. No statistics are available. The import is 2 000 - 2 500 tons annually. Most crayfish comes from USA (P. clarkii).

6.4. The annual catch of Astacus in Sweden was in 1987 about 50 tons (1.5 mill. specimens). The catch is estimated to have

been at least about 1 000 tons before 1907 when the crayfish plague hit the Swedish populations for the first time. Only in the three best lakes the annual yield was about 250 tons. If the management of crayfish populations is improved and the Pacifastacus is introduced in all the suitable waters the maximal yield is estimeted to reach more than 1 000 tons.

7. See I 3.3.

IV VALUE OF CATCHES AND PROCESSING

1. The value of 300 tons is about 15 million Swedish Crows.

2. See III 2.2. - 2.4.

3. See III 6.3. The dominating import from Turkey (Astacus leptodactylus) has ceased due to overfishing and the crayfish plague to. Swedes wants minimum 90 mm crayfish (total length). The Californian Pacifastacus leniusculus coming from the Sacramento River has an inferior taste probably due to muddy bottoms and direct processing after catching. Louisiana - Procambarus has a lower popularity than A. leptodactylus. The result has been a decrease in import. The taste of Pacifastacus in itself is better than that of A. leptodactylus.

V PROTECTION AND MANAGEMENT

1.1. Official size limit is 90 mm (total length) but societies of local exploiters have in many cases stated a higher limit of 100 mm. Local limitations occures as to numbers of traps per night per fisherman or numbers of nights open for fishing.

1.2. See V 1.1. and III 5.1. No restrictions according to sex, females carrying eggs or to condition.

2.1. Water level fluctuations seems to be of disadventage. Crayfish in running waters seems to survive better in cold clima or when the water becomes acidificated. They also stands better against eel predation. Silting has in some

cases caused mortality. Habitat improvement has been successful when stones or pieces of small tubes were laid on firm but smooth bottoms. When an armed plastic sheet with stones on it were laid on soft bottoms a new population established after stocking.

2.2. Increasing acidification is the great Swedish environmental problem and crayfish belongs to the most susceptible organisms. The effect on the crayfish populations are reported to be a) decrease of the total catch, b) decrease of the number of fry, c) increase of the mean length, d) prolonged period when the shell is soft. Experiments show that the egg-garrying, the egglaying and hatching are the most sensitive periods in the lifecycle. pH becomes lower especially when the snow is melting before the hatching. Moulting is also a critical period. pH 6 is as a rule the lower limit for an **Astacus** population to survive. Liming is a method widely used to prevent acidification in Sweden. The effects on crayfish populations are studied in several waters. >100 crayfish lakes have been limed by means of Govermental subsidy. Water-pollution control has somerimes resulted in decreased oxygen problems but in other cases the crayfish production also has decreased.

2.3. Most of the known parasites and diseases are found in Sweden but there has been no report about serious affected populations. The crayfish plague (**Aphanomyces astaci**) has caused a more than 90 per cent decrease of the total production and the number of populations. **Astacus** has a very low resistance and in spite of an intense selection pressure since 1860 when the plague struck the first **Astacus** population in Europe no resistant population is as yet known. The plgue came to Sweden 1907 and still new populations are struck each year. It has been impossible to get back a real productions of crayfish in more than 95 per cent of the lakes where the plague once has struck **Astacus**. In most lakes a few crayfish survive but do not form dense populations others than occasionally. If that is the case there will almost always be a new outbrake of plague. **Psorospermium haeckeli** will probably be a future problem at least for production of **Astacus**.

The most important predators are eel and mink (**Mustela vison**). Predation from other fish species do not seem to have a negative influence on production of crayfish.

2.4. Stocking is usd in some cases to try to introduce **Astacus** in lakes which has been excluded from a natural spreading of the species. Stocking hardly occures any more in order to restore plague struck populations. Srocking is by tradition made by using adult crayfish. Before release the crayfish are kept in cages during two-three days to prevent too much spreading. **Astacus** used for stocking is mostly trapped in natural waters.

VI CRAYFISH CULTURE

1. Some 50 crayfish farms produce a growing amount of **Astacus** for stocking material and consumption.

2.1. Ponds are mostly used.

2.2. Food is mostly waist agricultural products.

3. The total production is probably less than one ton.

VII PARASITES AND DISEASES

Aphanomyces: See V 2.3.

Thelohania contejeani is only found in a few waters. **Psorospermium haeckeli** is very common in **Astacus** populations but rare in **Pacifastacus** populations.

Branchiobdella sp. occurs rather dense during warm summers in some cases in some small lakes or ponds in southern Sweden. **Aphanomyces** is the only species that has been scientifically studied in Sweden. Each lake or river with **Aphanomyces** also is mapped and the development is followed. Restrictions are set up to prevent spreading. Spreading is probably made by man or birds. Man may store crayfish in cages in other waters than were they were trapped and birds are picking up dead or dying crayfish and transporting them to other waters.

I SPECIES, ORIGIN, GEOGRAPHICAL DISTRIBUTION

1. Nomenclature and origin of the species

1.1. **Pacifastacus leniusculus** Dana

1.2. Signalkräfta, signal crayfish

2. Origin of the species

2.2 Introduced from California 1960 - 1969 and British Columbia in 1973 - 1975.

3. Distribution

3.1. In Sweden with the western precipitation area of Lake Vänern.

3.2. Lakes, ponds, rivers, brooks, logs. Depth distribution mainly debending on type of bottom substrate. Swedish lakes frequently have such bottoms within the limnetic zone and soft sediment bottoms deeper. Occasionally specimens are caught at 60 m depht on stony bottoms.

3.3. Important determinants of distribution which are known today are climate, acidification, eel predation, oxygen shortage, soft bottoms. Climate probably will restrict distribution to the southern part of the total area of the country. The mogratin of eel to the Swedish coast has decreased dramatically and therefore gives crayfish better conditions. Acidification is a growing problem and excludes crayfish in hundreds of lakes. Oxygen problems are often reduced in lakes by better purification efforts.

3.4. The species is still introdused in new lakes and streams. Since 1967 about 1 000 lakes and rivers have been stocked, with P. leniusculuus.

3.6. P. leniusculus lives sympatrically with A. astacus in growing populations in about ten lakes. Pacifastacus seems to outcompete Astacus. Cross mating frequently occures in aquaria but no offspring is registered either in aquaria or in nature.

II POPULATION

1. Abundance and density of the population

1.1. Compared to the original distribution of Astacus before 1907 when the crayfish plague came to Sweden the abundance in the distribution is still sparse.

1.2. In 1990 several of the 1 000 populations have reached carrying capacity. Locally the yield is estimated to be higher than the yield of the original Astacus populations. The mean catch per unit effort (one trap emptified once during one night) has locally reached 20, maximum 130 in one trap. A local yearly catch in a eutrofic lake is 70 kg per hectare. The density and mean size of the stones on the bottom determines the density and mean size of the crayfish population.

III EXPLOITATION

1. Fishermen

1.1. Less than 5.

1.2. Less than 100.

1.3. No statistic available. Estimated number 3-5 000.

2. Basic for the crayfish fisheries

2.1. Crayfish catching is free. Minimum legal size is 10 cm.

2.2. The owner of the water can catch crayfish. The owner can be a private person or a joint property, a company or the Swedish government.

2.3. Catching areas can be hired from the owner.

2.4. It is common to by a fishing licence valid for one or several nights and sometimes permitting the use of a certain number of traps on a fixed part of the shoreline.

3. Fishing methods and the equipment

3.1.-3.2. The only used catching method is trapping. Most common is a cylinder trap with two entrances. Less used are funneltraps or small flat nets. All traps are baited. Most used baits are fish e.g. roach, bream, cisco.

4. Since when has the species been exploited ?

P. leniusculus was first introduced to Sweden in 1960. An exploitation has started gradually in some lakes after 1975.

5. Fishing seasons

The peak of the catch is during August and the first part of September.

6. Fishing operations and results

6.1. The catches per unit effort is

>50 in very good lakes
20 in good lakes
2-5 in avarage lakes

6.2. A few lakes are heavily exploited. Some are moderate but most are lightly exploited during the exponential population development. Experiancy shows that a rather hard fishing with a size limit of 100 mm (total length) favours the population development.

6.3. 2 000 - 2 500 tons are imported mostly from USA. Small amounts are imported from several other countries. The annual catch of Pacifastacus in Sweden was in 1987 about 200 tons (7 mill specimens). No statistics are available. See questionnaire about Astacus.

7. Changes in catches

See 4.

IV VALUE OF CATCHES AND PROCESSING

See 4 and 6.3.

V PROTECTION AND MANAGEMENT

1. Regulatory measures

1.1. Size limit is 100 mm of total length. Local limitations occures as to numbers of traps per night per fisherman or numbers of nights open for fishing.

1.2. See V 1.1., III 5.1. No restriction according to sex, females carrying eggs or condition.

2. Control or alteration of the environment

2.1. Water level fluctuations are of disadvantage. Silting has in some cases decreased production probably by high mortality. Habitat improvement have been succesful when stones or pices of small tubes were laid on firm bottoms. After matts of armed plastic with stones were laid on soft bottoms new populations were established after stocking.

2.2. Increasing acidification is the great problem in crayfish production. Fertilizing by pollution have in several cases increased production. Swedish waters have normally low production. Oxygen deficit as a result of too heavy pollution increase mortality. See questionnaire about **Astacus**. In a few cases **Pacifastacus** were stocked in acid lakes with no result.

2.3. **Pacifastacus** imported from Canada and USA have probably several ecto- and endo-parasiten as well as diseases. The Branciobdellide **Xironogiton instabilis** had a high frequency and intensity on imported specimens. It has not been observed on later generations in natural waters in Sweden. **P. leniusculus** is carrier of the crayfish plague but is resistent to it during natural conditions. During special conditions the resistance is reduced and the craydish dies. Pollution (heavy metals, biocides, poison) or stress during experimental or farming conditions seems to cause mortality

in plague. During moulting **P. leniusculus** is very susceptible to zoospores of **Aphanomyces**. Plague sometimes breaks out in the **Astacus** part if both species are present. The plague nay be caused by **Aphanomyces** carried by **P. leniusculus**. If this happend during a moulting period a part of the **P. leniusculus** population on the contrary may die.

Thelohania is observed on Swedish **P. leniusculus**. **Psorospermium** is common on **Astacus** and very rare on **Pacifastacus** even if the two species live sympatrically in the same lake and habitat. No other parasite or disease are observed neither North American nor Europeian.

Eel (**Anguilla anguilla**) has stopped population development in some cases. The development is fastest in lakes where all fish has been killed by means of retenone treatment.

2.4. Lakes are stocked with 2:nd stage fry, one-summer-old crayfish or adults. Mortality up to sexual maturation is estimated to be 90 - 95 % using fry. As little handling as possible is recommended because stress seems to decrease the resistance against the plague. Small adult speciments or one-summer-old crayfish seems to give best result.

VI CRAYFISH CULTURE

1. The purpose of crayfish cultivation

Produce crayfish for consumption. Provide stocking material. This should probably be at least one-summer-old. Acidification and climate decrease suitable waters for natural production therefore aquaculture in different froms are planned.

2. Methods

2.1. Organic waist products.

2.2. Several methods of farming are tested for production of adults for consumption. Fry production functions sufficient.

3. Intensity

3.1. See 2.1 above

3.2. One for fry production and 350 for consumption.

3.3. Production of about one million fry yearly. Production is still low but increases. Estimated full production about 500 tons.

VII PARASITES AND DISEASES

Crayfish plague: See V 2.3.

4.1.-4.2. **Aphanomyces** is visible on **P. leniusculus** as brownish - black spots of various size mostly less than 5 mm in diameter. Other fungi or diseases exeptionally cause the same type of melaninized spots. Normal frequency of spots in length class 90-120 mm is 2-20 %. Infected specimens have 1-2 spots. North American populations had 15-40 % infestation but not a higher intensity. In one case a higher frequency and intensity was caused by a suspected heavy matal pollution. Some populations lack **Aphanomyces** probably because infestation were not transmitted in the hatchery from parents to the fry which was stocked. Because of this **Astacus** is able to survive during at least a period sympatrically with **P. leniusculus**.

4.3. See V 2.3.

5. The frequency of **Aphanomyces** increases with length and/or age of **P. leniusculus**. As a harder fishing lowers length and age the frequency ought to be lower in such lakes. This seems also to be the case where fishing efforts have increased. No other method seems to be needed.

SWITZERLAND

B. Büttiker, R. Müller, E. Staub

I SPECIES, ORIGIN, GEOGRAPHICAL DISTRIBUTION

1.-2. Nomenclature and origin of the species (Table 1)

Table 1. Scientific and common names of the species. Origin of the species and if introduced, the main purpose. (Number refers to the questionnaire. For complete questions, see the questionnaire).

1.1. Scientific name(s)	1.2. Common name(s)/ in English	2. Origin of the species
Astacus astacus	Edelkrebs/ Écrevisse á pattes rouges/ Gambero di fiume	Introduced ([1]
Austropotamobius pallipes	Dohlenkrebs/ Écrevisse á pattes blanches/ Gambero di fiume	Native
Austropotamobius torrentium	Steinkrebs/ Écrevisse des torrents/ Gambero di torrento	Native
Astacus leptodactylus	Galizier/ Écrevisse á pattes grêles/ Gambero di galizia	Introduced probably after 1972 ([1]
Orconectes limosus	Kamberkrebs/ Orconecte/ -	Introduced probably after 1972 ([2]
Pacifastacus leniusculus	Signalkrebs/ Écrevisse de Californie/-	Introduced probably after 1972 ([2]

[1]) It is not sure if this species originally occurred in some parts of Switzerland. A. astacus may have been introduced in Switzerland a long time ago.
[2]) The purpose is not known because it is not known who has introduced them. In some cases they may have escaped from stabilization ponds.

Table 2. Distribution of the crayfish species in Switzerland.

Species	3.1. Geographical distribution	3.2. Description of the habitats	3.3. Determinant of distribution	3.4. Changes in distribution	3.5. Frequency in the distribution area	3.6. Hybridization
Astacus astacus	In the Northern part of the country	In small lakes or ponds of Swiss plateau	No data available		No data available	No data available
Austropotamobius pallipes	In the whole country except where A. torrentium exists	In flowing waters and in some small lakes or ponds	No data available		No data available	No data available
Austromotamobius torrentium	In the North-East part of the country	In flowing waters and in some small lakes or ponds	No data available		No data available	No data available
Astacus leptodactylus	Scattered (e.g. in lake Geneva and Lake Zürich)	Lakes	No data available		No data available	No data available
Orconectes limosus	Scattered (e.g. in Lake of Bienna and in River Aar)	Lakes, rivers	No data available		No data available	No data available
Pacifastacus leniusculus	Scattered (e.g. in Lake Geneva)	Lakes	No data available		No data available	No data available

II POPULATION

1. Abundance and density of the population

In general populations seem to be rather sparse. However, in some lakes of the plateau, Astacus astacus is abundant. A very dense population of A. astacus in Lake Bret (Canton of Vaud) has suddenly dissapeared without known reason. In some lakes of Graubünden A. pallipes is very abundant (altitude up to about 1 000 m).

III EXPLOITATION

1. Fishermen

1.1. No professional.

1.2. One semi-professional.

1.3. The number of subsistence and recreational fishermen is not known.

2. Basis for the crayfish fisheries

The right for fishing belongs to the Cantons.

2.1. Crayfish catching is never free.
Sportfishing licence or special crayfish licence is needed.

2.3. Catching areas can also be hired.

3. Fishing methods and equipment

The following fishing methods are forbidden according to the federal fishing law:

- electricity and explosives
- weapons, ties, chemical products, skin diving
- changing the water flow
- fishing by hand

The Cantons decide which methods may be utilized in their area. Normally these include traps and balances.

4. Exploitation

The native species have always been exploited. The other species are not really exploited, they may be caught by chance in lakes by professional fishermen.

5. Fishing seasons

According to the Federal law, the crayfish must be protected for 40 weeks each year. This period is fixed by the Cantons and it is normally between October and July. In some Cantons crayfish fishing is forbidden.

6.-7. Fishing operations and results

There is no statistics of crayfish catch.

IV VALUE OF CATCHES AND PROCESSING

Table 4. Value, use and foreign trade of crayfish catch in Switzerland.

1. Value of catches	2. Use of catch		3. Foreign trade	
	Fisherman's own use	selling	import	export
About SFr 35,-/kg	Yes	No	30-40 tn(1	No

1) estimated (mainly A. astacus and A. leptodactylus). No more precise statistic of imports is available.

V PROTECTION AND MANAGEMENT

1. Regulatory measures

There is a Federal law which gives a protection period of 40 weeks for all species.
There are also size limitations:

Astacus astacus:	12 cm
Austropotamobius pallipes:	10 cm
A. torrentium:	7 cm

There are no restrictions with respect to sex or limitation of numbers.

2. Control or alteration of the environment

Protection against physical and chemical alterations of waters is regulated in different laws, but not specifically for crayfish. No special measures are taken to protect crayfish environments.

VI CRAYFISH CULTURE

-

VII PARASITES AND DISEASES

No studies have been done on crayfish diseases in Switzerland. It is thought that at some places crayfish plague is present in an endemic state, in the crayfish population, without destroying it.

TURKEY
S. Tünali

I SPECIES, ORIGIN, GEOGRAPHICAL DISTRIBUTION

1.-2. Nomenclature and origin of the species (Table 1)

Table 1. Scientific and common names of the species. Origin of the species and if introduced the main purpose. (Number refers to the questionnaire. For complete questions, see the questionnaire.)

1.1. Scientific name(s)	1.2. Common name(s)/ in English	2. Origin of the species
Astacus leptodactylus	Kerevit	Native

III EXPLOITATION

1. Fishermen

1.1. 1985: 6 000 fishermen
1986: 4 000 fishermen

6. Fishing operations and results

6.4. Total annual catch

1985: 6 244 metric tons
1986: 1 585 metric tons

Reason for the decrease in catches is the crayfish plague (**Aphanomyces astaci**), which reached Turkey in 1985 and spread rapidly throughout the country.

IV VALUE OF CATCHES AND PROCESSING

Value of the crayfish catches.

	Price/kg	Total
1985:	2 000 T.L. (~ 2.2 US$/kg)	~ 13.7 mill. US$
1986:	3 500 T.L. (~ 3.9 US$/kg)	~ 6.1 mill. US$

Export 1985: 5 300 metric tons, (85 %)
1986: 1 300 metric tons, (82 %)

About 70 % of the exported crayfish are alive.

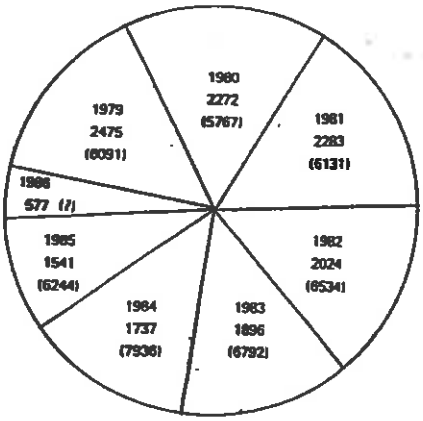


FIGURE 1. **Astacus leptodactylus;** annual export of Turkey (in metric tons) according to the Turkish customs statistics. In brackets estimated production (P.-J. Laurent 1987).

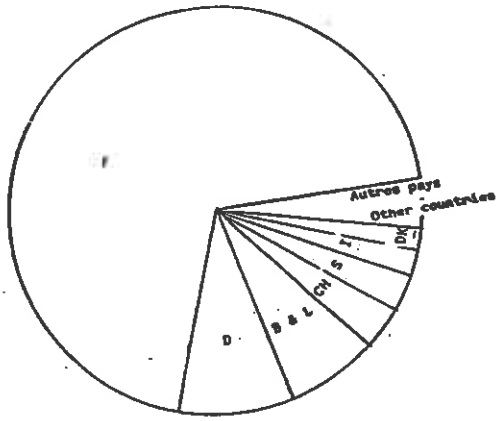


FIGURE 2. Percentage of the Turkish production bought by different countries (in 1979). Sources Turkish customs statistics. F=France, D=Fed.Rep.Germany, B=Belgium, L=Luxemburg, CH= Switzerland, S=Sweden, I=Italy, DK=Denmark (P.-J. Laurent 1987).

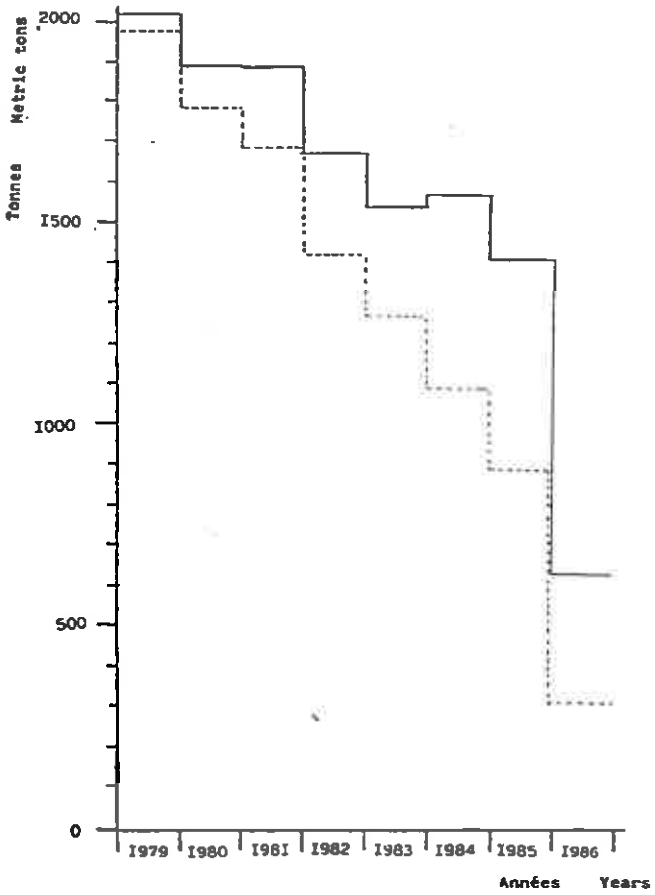


FIGURE 3. Comparison of the data from the French customs statistics with the Turkish ones (P.-J. Laurent 1987).

UNITED KINGDOM
D. M. Holdich, K. Bowler, R. Lowery

I SPECIES, ORIGIN, GEOGRAPHICAL DISTRIBUTION

1. Nomenclature and origin of the species (Table 1)

Table 1. Scientific and common names of the species. Origin of the species and if introduced, the main purpose. (Number refers to the questionnaire. For complete questions, see the questionnaire.)

1.1. Scientific name(s)	1.2. Common name(s)/ in English	2. Origin of the species
Astacus astacus	Noble crayfish	Introduced from Bavaria to see if it could survive in Britain
Astacus leptodactylus	Turkish crayfish Long clawed crayfish Swamp crayfish	Introduced from Eastern Europe for restaurant trade; have escaped into wild
Austropotamobius pallipes	White-clawed crayfish	Native
Cherax quadricarinatus	Red claw	Introduced for aquacultural purposes
Pacifastacus leniusculus	Signal crayfish	Introduced from Sweden in 1976, for aquaculture purpose

3. Distribution (Table 2)

Table 2. Distribution of the crayfish species in the United Kingdom.

Species	3.1. Geographical distribution	3.2. Description of the habitats	3.3. Determinants of distribution	3.4. Changes in distribution	3.5. Frequency in the distribution area (% of waters)	3.6. Hybridization
Astacus leptodactylus	Restricted to South-East England	1-3 m deep ponds, canals with very slow moving water	More tolerant than natives of poor water quality	Gradually spreading range in wild		None
Austropotamobius pallipes	Abundant throughout much of England and Welsh Borderland except where affected by crayfish plague	- In large semi-closed reservoirs containing numerous hiding places, - in water filled quarries, - in medium to fast flowing rivers and streams with rocky hides.	- Water quality - pollution - pH, water hardness([1]) - winter temperature - quality of the bottom	Much more abundant than previously thought	In the Midlands about 25-50 %	None
Pacifastacus leniusculus	>60 farmed populations in England + Wales. 13 wild populations mainly in Southern and Eastern England	As for natives	More tolerant than natives of poor water quality. Temperature main determinant	Becoming more abundant. Wild populations developing in Central, Southern, Western and Eastern England		None
Cherax quadricarinatus	Kept in captivity at Nottingham University at 26°C					None

[1]) rarely found in waters below pH 6 or above pH 8

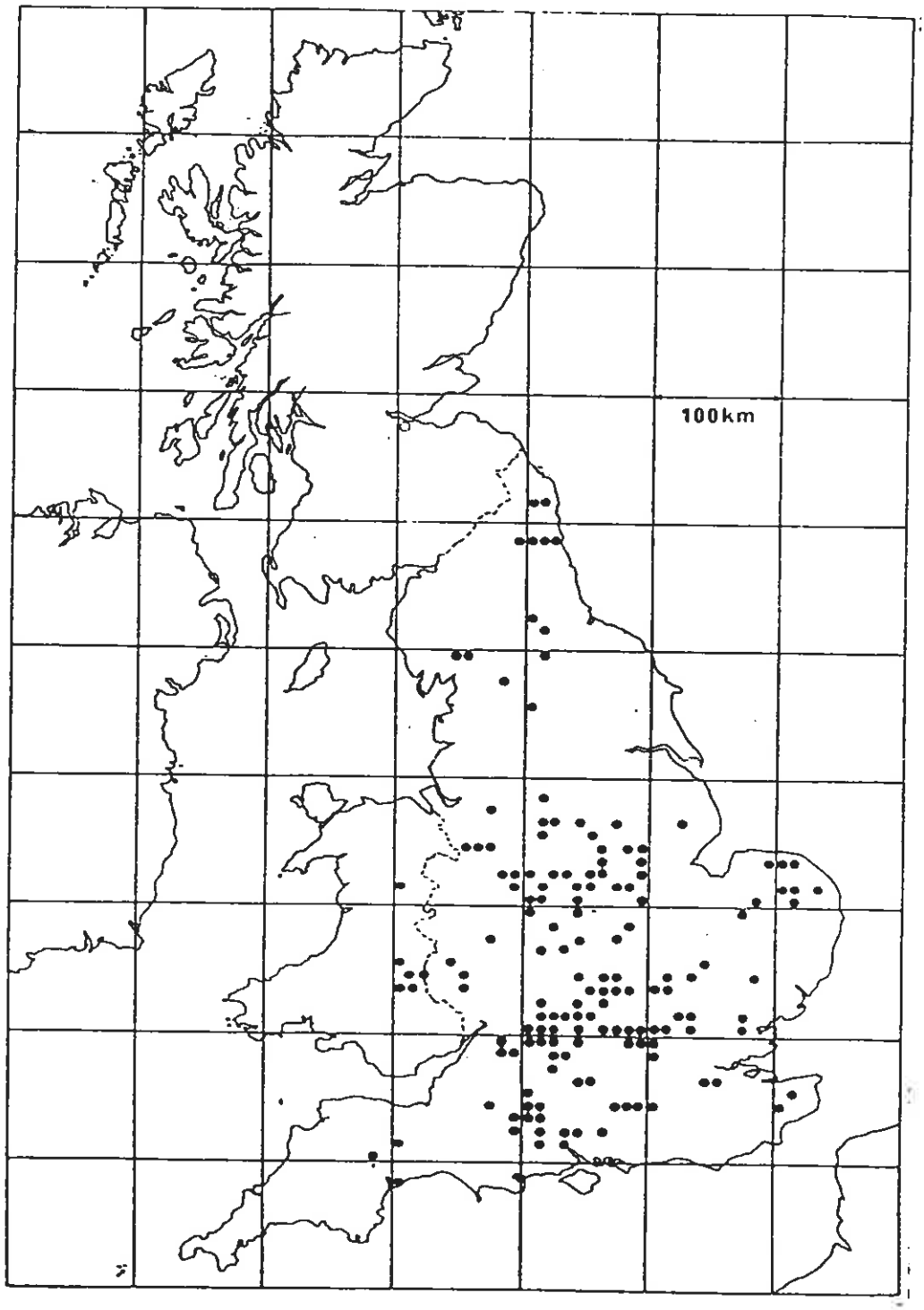


FIG 1 The distribution of *Austropotamobius pallipes* in Britain as compiled from post-1970 records and based on 10 km². In many cases the black circles represent a number of records for that square

II POPULATION

1. Abundance and density of the population (Table 3)

Table 3. Abundance and density of the crayfish populations in the United Kingdom.

Species	1.1. Average abundance in the distribution area	1.2. Population size and density in different habitats	1.3. Changes in abundance	1.4. Reasons for the changes
Astacus astacus	Very abundant	25/m^2 in one canal in London		
Austropotamobius pallipes	In the Midlands and North England fairly abundant. Southern England - abundant in some rivers and lakes	Streams- River Leen has been estimated to number about 2 000 of crayfish/ km. Usually associated with wiers of boulders - 20/m^2 in certain areas. Reservoirs and quarries - 1 - 10/m^2	Decreased in few places, particularly in Southern England.	Organic effluent in streams and draining or reservoirs, crayfish plaque
Pacifastacus leniusculus	Very abundant	35/m^2 in parts of one river in Wessex. Max 26/m^2 on one farm in England.		

III EXPLOITATION

1. Fishermen

Fishing for the native species is not a commercial enterprice in the U.K. In some parts of England crayfish used to be collected on a local basis for consumption by people from the locality. Some fishermen are known to use traps for crayfish whilst they are fishing for fish. It is now illegal to take the native crayfish as to sell it under the term of the Wildlife and Countryside Act, 1981.

Pacifastacus leniusculus (signal crayfish) is exploited by means of crayfish farms of which there are 62 registered (under the Diseases of fish Act, 1983) in 1990.

Signal crayfish are also being harvested from wild populations in two locations in Southern England.

2. Basis for the crayfish fisheries

Fishing for signal crayfish is prohibited except with license from the water authority. This regulation is widely disregarded by amateur fishermen catching crayfish for their own use. It may become common in future that the catching areas can be hired.

3. Fishing methods and equipment

Signal crayfish traps are baited with oily fish or meat and left in ponds for up to 24 hours. Fyke and seine nets are also used on crayfish farms.

4. -

5. Fishing seasons

Fishing for native crayfish is totally prohibited.There are no legal limitations but difficulties in catching crayfish limit the fishing season of signal crayfish from May until October - November.
Farmers are trying to devise ways of expanding the seasons.

6. Fishing operations and results

Approximately 6-8 tonnes of signal crayfish are harvested but this depends on climatic conditions, ie. the hot weather in 1989 resulted in many crayfish dying in transit.

7. -

IV VALUE OF CATCHES AND PROCESSING

1. Value of catches

Signal crayfish fetch about £ 13/kg so for 6 tonnes the value of catch would be £ 18 000.

2. -

3. Foreign trade

Customs figures give a very misleading picture. At present there appears to be no export but 43 tonnes are listed for 1989 - the confusion is probably due to crawfish (spiny lobsters) being lumped together with freshwater crayfish.

Imports of **Procambarus clarkii** occur for the pet trade and come S.E. Asia. Juvenile signal crayfish are imported from Sweden. P. clarkii and A. leptodactylus are imported for restaurant trade.

V PROTECTION AND MANAGEMENT

1. Regulatory measures

Public and government now much more aware of need to conserve native crayfish. Native species protected by Wildlife and Countryside Act.

2. Control or alteration of the environment

Changes in physical and chemical features are carried out but little concern is usually given to crayfish. Although native species is now protected by law its habitat is not, however, many people are now more concerned about the damage which environment alteration might do.

VI CRAYFISH CULTURE

1. The purpose of crayfish cultivation

Pacifastacus leniusculus juvenils are sold for further growing on to an eatable size. (Some farms are offering breeding pairs of **P. leniusculus** for sale at over £ 20.) Juveniles sell for 50 pence and adults for £ 1.

2. Methods

2.1. Juveniles are fed with algal material and boiled vegetables. Trout pellets, macrophytes and animal material are served to adults.

2.2. Crayfishes are growing in trout and carp ponds and large plastic or fibre-glass tanks. Some polyculture with carp is undertaken.

3. Intensity

Over 60 signal crayfish farmers are registered (compared with 38 in 1987). Many grow them up to marketable size and sell them to restaurants. Some farmers sell off surplus juveniles to other farmers.

Turkish crayfish are farmed at one location is Southern England.

VII PARASITES AND DISEASES

Protozoan diseases:

1. The only studied parasite which appears to affect the populations of **A. pallipes** is white tail disease **Thelohania contejeani**.

2. Few details are known but it is thought to be present throughout the year and is transmitted from one crayfish to another when they eat the bodies of dead individuals.

3. **T. contejeani** appears to occur throughout the country.

4. It takes about 1-2 years to reach maximum infection in an individual. An individual can still moult and reproduce when infected although tends to be sluggish.

Juveniles are rerely infected althought it is not unknown. In closed systems it can reach a 9 % level of infection in the Midland but in open systems only about 0.5 %.
The disease can be a problem to crayfish culture if it is allowed to develope.

5. The infected individuals must be removed before they can be eaten by others.

Fungal diseases:

Since 1980 crayfish plague has struck a number of native populations. It is 100 % lethal. It can be transmitted by signal crayfish, an equipment, by contaminated water, on fish such as trout, and on plants.

VIII FURTHER INFORMATION

Currently, there are a number of university groups working on the biology of native and introduced crayfish. Funding has increased over the last few years for all but the aquacultural aspects of research. Money is particiularly available for the conservation of the native species. The main groups of workers are situated at Nottingham, Birmingham Cardiff and Leicerter Universities. The National Rivers Authority and the Nature Concervancy Council also have an interest in native and introduced species.

There are large populations of **A. pallipes** still present in the country but these are under threat from **Aphanomyces astaci** which has occurred in several river systems since 1980. Signal crayfish numbers are increasing + several rivers are known to carry substantial and increasing numbers. In the past few years large numbers of **A. leptodactylus** have been found in a London canal, system which connects to all parts of the Midlands. It seems likely that this species will spread.

YUGOSLAVIA

J. Obradović

I SPECIES, ORIGIN, GEOGRAPHICAL DISTRIBUTION

1.-2. Nomenclature and origin of the species (Table 1)

Table 1. Scientific and common names of the species. Origin of the species and if introduced, the main purpose. (Number refers to the questionnaire. For complete questions, see the questionnaire.)

1.1. Scientific name(s)	1.2. Common name(s)/ in English	2. Origin of the species
Astacus astacus	Riječni rak/ Plemeniti rak/ Crayfish	Native
Astacus pallipes	Rak bjelonogi/ Tak potočni/ Crayfish	Native
Astacus lepto-dactylus	Rak barski/ Rak uskoškari/ Crayfish	Native
Astacus torrentium	Rak kamenjar/ Rak kamenjak/ Crayfish	Native
Astacus sp. (probably A. astacus or some subspecies of it)	Rak plavi/ Crayfish	Native

3. Distribution (Table 2)

3.5. - 3.6. -

Table 2. Distribution of the crayfish species in Yugoslavia.

Species	3.1. Geographical distribution	3.2. Description of the habitats			3.3. Determinants of distribution	3.4. Changes
		Water type	Bottom	Quality of water		
Astacus astacus	Many areas throughout the whole country	Rapid streams, waters coming from mountains	Gravel	-	Pollution, water course construction, Branchiobdela infection, mean factor (catch, introduction of predators - different fish species)	Gradual changes (in some regions) in the last 30-40 years and dramatic changes in some new regions in the last 10 years
Astacus pallipes	Western and southwestern parts of Yugoslavia	Rapid streams, waters on higher mountains	Gravel, gravel and stone	-	No evidence	No evidence
Astacus torrentium	Many areas in the whole country	Rapid streams, waters like Astacus astacus	Pebble	Very turbid	No evidence	No evidence
Astacus leptodactylus	Northern parts of Yugoslavia	Slow streams, lakes, rivers	Gravel, mud mixed with sand	As waters in fish ponds	No evidence	No evidence
Astacus sp.	Southwestern parts of Yugoslavia	Rapid streams	Gravel	Very turbid	No evidence	No evidence

II POPULATION

1. Abundance and density of the population (Table 3)

Table 3. Abundance and density of the crayfish population in Yugoslavia.

Species	1.1. Average abundance in the distribution area	1.2. Population size and density in different habitats	1.3. Changes in abundance	1.4. Reason for the changes
Astacus astacus	In some creeks dense	-	Decreased or absent in some waters and rapid expansion in some other areas	Deterioration of the environmental conditions, diseases
Astacus pallipes	In some creeks from average to dense	In some areas there are streamlets with only a few individuals	No evident changes	-

III EXPLOITATION

1. Fishermen

1.1. 0

1.2. Unknown.

1.3. Unknown.

2. Basis for the crayfish fisheries

2.1. Catching is not free.

2.2. The owner of the water area issues catch permission.

2.3. Catching areas can not be hired.

3. Fishing methods and equipment

3.1. Hand picking is used.

4. Since when has the species been exploited ?

A. astacus from the Lika area has been exploited for about more than one century.

5. Fishing seasons

5.1. 16.5.-30.10.

5.2. No varation in date.

6. Fishing operations and results

Total annual catch (all species) 1986: 43 000 kg.

7. Changes in catches and the reasons for the changes during the last ten years and/or earlier

In Yugoslavia nothing really has been done with respect to changes in catches though in some areas native populations are in danger to become extinct.

IV VALUE OF CATCHES AND PROCESSING

Price per kg (all species) 6 000 Din. (~6 US$).
Value of total catch in 1986: 260 000 US$ (estimated).

No processing industry exists in Yugoslavia.

V PROTECTION AND MANAGEMENT

1. Regulatory measures

1.1. None.

1.2. Astacus astacus
Protection of population is based on limiting the size of crayfish (10 cm) and on restricted fishing seasons.

1.3. None.

2. Control or alteration of the environment

2.1.-2.4. None.

VI CRAYFISH CULTURE

None.

VII PARASITES AND DISEASES

Virus diseases

No virus studies have been carried out on crayfish in Yugoslavia.

Bacterial diseases

No bacterial diseases affecting crayfish have been noted.

Fungal diseases

Crayfish plague (**Aphanomyces astaci**).

1. Crayfish species

Astacus astacus.

2. Distribution of the disease

Crayfish plague has been registered in Yugoslavia for the first time in 1983 in only one case.

3. Significance

Approximately 13 160 crayfish were kept in tanks of a warehouse. In four days a great number of them died (20 %). All of the examined crayfish showed symptoms characteristical of the crayfish plague. The fungal hyphae, zoosporangia and zoospores, which were invariably present in the resticted areas of the exoskeleton of crayfish, were identifed as

Aphanomyces astaci on the basis of morphological and some biological characteristics. We found that the tissues around the foci became brown and necrotized, but we could not find a significant number of hyphae growing outwards from the foci of infection on the skeleton.

Burned spot disease

1. Crayfish species

Astacus astacus.

2. Distribution of the disease

In some waters very frequent.

3. Significance

The symptoms of burned spot disease were observed but not examined. Some crayfish had on their exoskeleton one to five lesions with a diameter varying between 0.3 - 3 cm and more. Old specimens had more lesions than the younger ones.

Protozoan diseases

White tail disease (Thelohania contejeani).

1. Crayfish species

Astacus astacus.

2. Origin of the disease

White tail disease has been found in Yugoslavia for the first time 1981.

3. Distribution

White tail disease is found only in the southern parts of Yugoslavia.

4. Significance

In our opinion the percentage of infected individuals is very small.

Helminths

Branchiobdella sp.

1. Crayfish species

Astacus astacus.
Astacus pallipes.

2. Origin of the disease

Branchiobdella sp. is present on crayfish in Yugoslavia.

3. Distribution

Parasite is present in many crayfish areas.

4. Significance

In some areas Branchiobdella infection is present in hihger percentages.

Tumours

There are no reports of crayfish tumours in Yugoslavia.

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SISÄLTÖ – INNEHÅLL – CONTENTS

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