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## FRENCH SARDINE AND HERRING FISHERIES: A TENTATIVE DESCRIPTION OF THEIR FLUCTUATIONS SINCE THE EIGHTEENTH CENTURY.

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## Abstract

In order to make up a set of data available for a study of climatic induced fisheries variations, an historical description of sardine and herring fisheries is attempted. It is supposed that, during some periods, chronological records of landings might provide useful indications of availability and total abundance of these highly variable stocks.

Herring fishing areas have moved during the past centuries. The ratio of fresh to salted herrings in the landings shows what part of the yield was fished in the Channel. During the 18th century the fishery shifted from Yarmouth to Channel waters. This southward displacement coincided with the climatic deterioration of the end of the 18th century. As the climate became warmer at the beginning of the 19th century, the Channel fishery declined. Again, during the two major coolings of the end of 19th and early 20th century, the increase of fresh landings in the Channel harbours showed a westward extension of herrings. Good periods in the Channel fishery seem to correspond to the Bohuslan periods described by Devold. They occur during climatic coolings.

The sardine fishery was very coastal and dependent on the migration of immature fish towards the coast. This displacement is probably dependent on the extent of summer warming. So the catches might be related to both short and long-term climatic variations. Good and poor yields have been reported since the 18th century. To some extent, the maxima and minima of the sardine fishery are comparable to the periods of warming and cooling since 1800. A good coincidence is observed with the long-term variations of other sardine stocks.

## Resumen

Se intenta una descripción histórica de las pesquerías de sardina y arenque, con objeto de proporcionar datos para un

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estudio de las variaciones de las pesquerías debidas a causas climáticas. Se supone que, durante algunos períodos, los registros cronológicos de los desembarcos pueden proporcionar indicaciones útiles sobre la accesibilidad y abundancia total de estos recursos altamente variables.

Las áreas pesqueras del arenque se han desplazado durante los siglos pasados. La relación entre el arenque fresco y en salazón en los desembarcos es una indicación de la proporción de las capturas pescadas en el Canal. Durante el siglo XVIII la pesquería se trasladó desde Yarmouth a las aguas del Canal. Este desplazamiento hacia el sur coincide con el empeoramiento climático a fines del siglo XVIII. Al hacerse el clima más templado a comienzos del siglo XIX declinó la pesquería del Canal. Otra vez, durante los dos enfriamientos más importantes, a fines del siglo XIX y comienzos del XX, el aumento de desembarcos de arenque fresco en los puertos del Canal mostraba que el arenque se había extendido hacia el oeste. Los períodos buenos en la pesquería del canal parecen corresponderse con los períodos de Bohuslan descritos por Devold. Tienen lugar durante los enfriamientos climáticos.

La pesquería de sardina era muy costera y dependía de la migración hacia la costa de los peces inmaduros. Este desplazamiento depende probablemente del grado de calentamiento en el verano, con lo que las capturas pueden ser relacionadas con las variaciones climáticas tanto cortas como largas. Desde el siglo XVIII se han registrado rendimientos buenos y malos. Los máximos y mínimos de la pesquería de sardina son comparables, en cierta medida, con los períodos de calentamiento y enfriamiento desde 1800. Se observa una buena coincidencia con las variaciones de largo período de otras poblaciones de sardina.

#### Introduction

We think that the possibility of predicting future changes in fisheries will depend, in part, on our knowledge of past variations and on our ability to find correlations between climatic and fisheries variations during historical times. Of course, our predictive ability will also depend on a knowledge of future climate.

For this reason, an attempt has been made to set up long sets of data which can be used to detect long-term trends and to describe various ecological situations.

The accuracy of fisheries data collected by historical research is rather far from that required by population dynamic scientists. The total catch of a species and sometimes, the total numbers of fishing boats, are usually the only available data, for more or less extended periods. But we may suppose that, for limited time lags of constant fishing effort, chronological records provide indications on the availability and abundance of some highly variable stocks.

#### Historical Data

The historical data used here mostly come from literature. The main sources of data are archives and printed reports from the fishery administration (Coutancier, 1985). In 1726, the "Service des Pêches" was set up inside the military organization of "Inscription maritime". In charge of it, Lemasson du Parc described accurately the whole coastal fisheries between 1723 and 1727 (Dardel 1941a). Others reports from fisheries inspectors Sicard and Chardon, and by Duhamel du Monceau (1769 - 1782), give some data. Indirect evidence has been sought in harbour records on ship and good entries, commercial correspondence between fish merchant, annals of Chambers of Commerce, and Judgements of courts of law (Amirautés). Handwritten sources are quoted in the references.

The properly so-called fisheries statistics issued by the "Inscription maritime" date from 1814 onwards. A few of these report may be found for earlier years. They record yearly the total amount of money yielded by the fisheries and the number of sailors and fishing boats for each "quartier", including one or several harbours. Coastal and distant water fisheries are differentiated. In some cases, the products of the different fisheries are separated. All these archives are sparse, dispersed between the Public, Departmental and Navy's Records Offices. Many have been destroyed. A better set of data started in 1866, with the publication of the statistical reports (Anonymous a, 1866 - 1984).

Sardine and Herring fisheries were chosen for this study for the following reasons:

- These species supported important fisheries which yielded salting, then canning activities, leaving numerous records.

- The highly variable recruitment and availability of these coastal, pelagic, short lived fishes are known to be sensitive to environmental fluctuations.

Both are situated at the boundary of their geographical ranges. French herring and sardine populations are respectively situated at the southern and northern limits of their habitats. So we can expect that long-term variations of sea temperature, small in absolute value, but with large geographical extent, will induce displacements of their boundaries and changes in the fisheries. During a warming period, we can expect a shift of the populations polewards and during a cooling period the contrary.

The climate of the 17th and 18th century is known as the Little Ice Age. From 1800 onwards, a general warming occurred in the northern hemisphere and culminated about 1950. The ten-year running means of central England temperatures (from Manley in Mason, 1976 and Lamb, 1977) was used as a climatic index with

which to compare long-term variations in the North Sea and English Channel fisheries. The sea-surface temperatures of the eastern North Atlantic, from 1850 onwards (in Lamb, 1977) and the Paris observatory records were also used (Dettwiller, 1967).

#### Herring and sardine fisheries

Herring were caught by fishermen of Normandy, Picardy and Boulogne (fig.1). Three distinct fisheries followed one another, between late spring and the beginning of winter. These began with spawning herring in the northern North Sea (Scotland, Orkney), proceeded to the East Anglian coast and ended in the English Channel in autumn. Usually the fishing season ended in early winter after the spawning of Channel populations. Sometimes, westwards of Dieppe, the fishing continued in winter, on post-spawning herring.

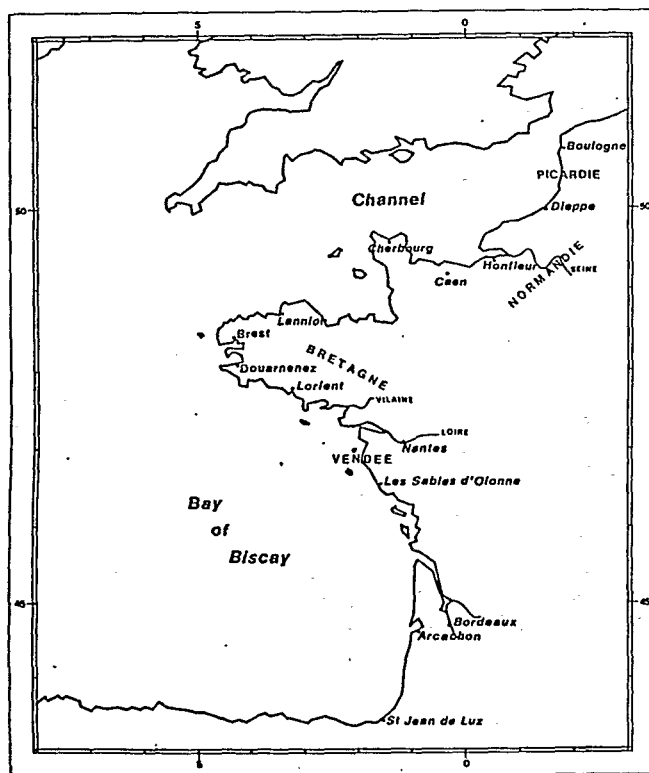


Fig. 1.- Map of the French fishing areas of sardine and herring

The North Sea fisheries required distant water vessels of several tens of tons burden. In the Channel, fishing was often carried out by the same ships, and also by smaller ones. Vessels changed little until the end of the nineteenth century. From 1872 to 1880, ketches or dundeeds took the place of luggers; then steam drifters were progressively put into service. Long drift nets were used. From 1860 onwards, as cotton nets replaced hemp ones, fishing gear became lighter and fishing efficiency increased.

Herring fished in the North Sea was always salted on board. Herring caught in the Channel was landed fresh or poorly salted. Therefore, it is possible to know if the archive data concern North Sea or Channel fish. Until the introduction of stram drifters and the use of ice, it may be assumed that fresh herrings were fished in the English Channel, while salted herring came from the North Sea. Since it is easiest to catch fish in home seas, one may assume that if a distant-water fishery develops while the home fishery decreases, (in the absence of political, economical or sociological reasons), that is surely because the home stock had declined.

At the beginning of the eighteenth century, some records attest to a reduction of herring abundance in the Channel (Dardel, 1941b). In 1707 it was noted that schools were less abundant than in the past. From 1720 to 1729 the Channel herring were depleted; the only fishing was in Yarmouth waters. Some years later, from 1730 to 1735, no herring appeared along the coast of Dieppe, but they were abundant on Dutch and English coasts. Curiously, postspawning herrings were abundant in Fécamp, Le Havre and the whole Baie de Seine where they were stranded in great numbers and taken from the shore during the winter of 1730. This is in good agreement with the Dieppe landing curve, which showed a decrease of fresh and an increase of salted herring (fig. 2).

From 1750 onwards, total Dieppe landings increased abruptly until the 1770's. At the same time, fresh production took first place. In 1773, herrings were reported as very abundant off the Texel coast and in the western approaches of the English Channel, by Duhamel du Monceau (1769 - 1782). In 1780 the war prevented the fitting out of boats and strongly reduced the fishing effort of Dieppe (fig.2). But the fishery recovered quickly in Dieppe and also in Boulogne. Although we have no quantitative data during the Révolution and Empire period (1790 - 1815), it seems that herring were abundant. According to Dardel (1941b), herring imports from foreign countries, were very weak at the end of the eighteenth century; it shows that French fishing was improving and able to supply internal consumption and export to the colonies. Dieppe remained the first herring fishing port at this time. After intensive fishing off Scotland in the mid-seventeenth century and being limited to the Yarmouth and Channel grounds during the first half of the eighteenth, Dieppe devoted its main efforts to the production of fresh herring at the end of the century (Dardel, 1941b).

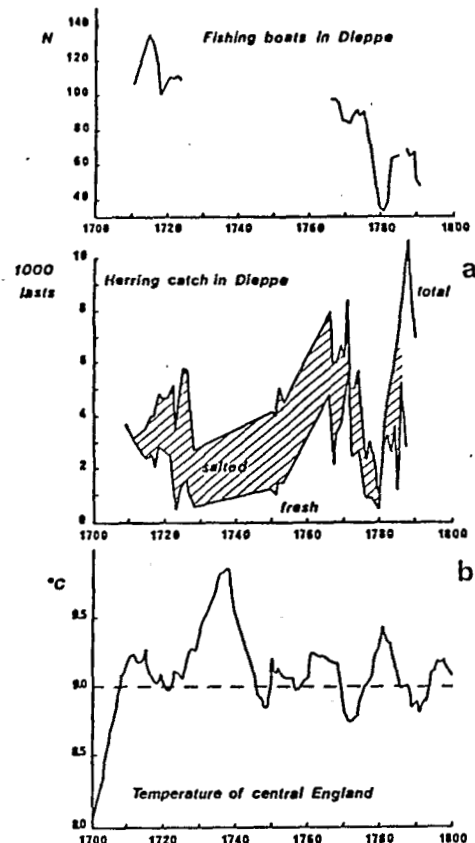


Fig. 2.- (a) Herring fishing boats (top) and landings (middle) in Dieppe from Dardel (1941b) and from Ms KE 83 (Coutancier pers. comm.)

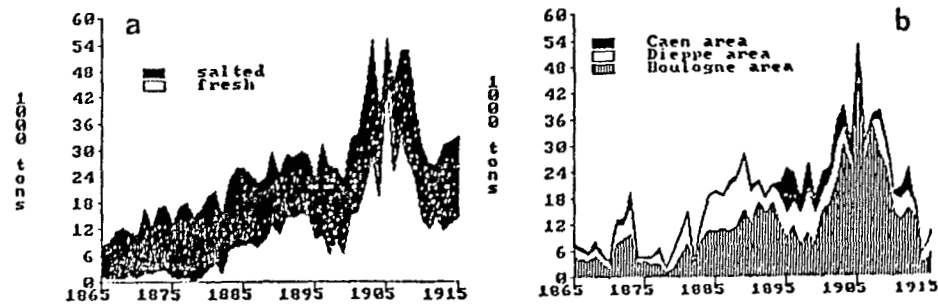
(b) Ten year running means of Central England temperatures compiled by Manley (in Mason, 1976), (bottom).

The first data available from the beginning of the nineteenth century show a decrease as compared to the late eighteenth (Dardel, 1941b; Pichon, 1831). The fishing slowly recovered during the first half of the century but deep changes affected the fishing harbours, Boulogne and St Valery outgrew Dieppe which lost its predominance.

A change in the migratory routes of herring seems to have occurred between 1815 and 1826 approximately, a change which looks like that of 1730 (Pichon, 1831; Dardel 1941b). The passage of herring schools off Fécamp and Le Havre was very brief (1 or 2

days) and herring found their way directly to Cherbourg; they did not come near the coasts or the Baie de Seine (fig. 1) as they used to do before. At that time herring were abundant on the south coast of England.

The analysis of French herring landings during the first half of the nineteenth century is complicated by the smuggled herring imports. The French government prohibited the purchase of foreign herring. Nevertheless, some ship owners fitted vessels in bad condition to carry herrings bought from Scottish fishermen. This smuggling reflected the poor profitability of French fisheries. Moreover, it disorganized the fishing industry of loyalist harbours. Nevertheless it means a certain rarity of herrings in the Channel at that time.



(Left)  
Fig. 3.- (a) Salted and fresh herring landed in Boulogne (from Dardel 1941b).  
(Right)  
(b) Fresh herring landed in different areas of the eastern Channel - (from the Statistiques des Pêches maritimes).

After the middle of the century the growth of fishing effort was rapid and rather steady. The total catch increased in proportion. In the landings of Boulogne (fig. 3), salted herrings were predominant from 1855 to 1880. Then the catch of fresh herring increased quickly. Two distinct maxima occurred in 1890 - 1958 and in 1900 - 1910. During the whole of this period, landing at Normandy harbours increased (fig. 3). The fishery moved westwards, as far as Cherbourg. These events probably mean that herring increased in abundance in the Channel, and that the population extended westwards.

After the first world war, total landing at Boulogne were still increasing. But the multiplication of the steam-drifters, and the use of ice widened the fishing area. Then, steam-tractors began to fish herring on new grounds and their higher profits eliminated the drifters. Fishing technology changed rapidly and so did effort. Total herring landings increased until the 1950s, then decreased. But only a small part of this yield was caught in the Channel (fig. 4).

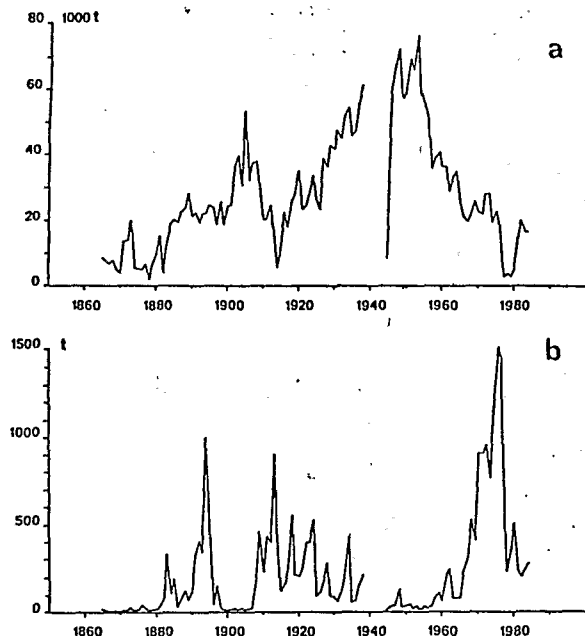


Fig. 4.- Fresh herring landed in Channel harbours (top) and in Biscay harbours (bottom). From the Statistiques des Pêches maritimes. Note changes in landing scales.

Herrings are rarely seen westwards of Cap d'Antifer while, in some years, good catches are made in the Baie de Seine. But another population of *Clupea harengus* occurs in the coastal waters of southern Brittany (Le Gall, 1926, 1943). The core of the stock is centred on the Vilaine and Loire river estuaries (fig. 1). Very exceptionally herring can be caught as far south as Arcachon. This population is distinct from the Downs stock since spawning (and fishing) occur at different times. Channel herring is a late autumn or winter spawner while Biscay herring is a late summer spawner. In the mid-eighteenth century the fishing occurred only during September, while Le Gall (1943) observed it in November. This very small stock supports a relatively unimportant fishery. Nevertheless it is striking that from time to time this stock is rediscovered, exploited for a few years, and then abandoned.

The first record of the Brittany herring is that of Le Masson du Parc in 1728. He pointed out that herring had been plentiful in the Loire estuary for several years. Duhamel du Monceau reported herring fishing between the Loire and Vilaine

estuaries in 1741, 1756 (exceptional catch) 1757 and in 1773. This fishing is still attested to just before the French Revolution: in 1788 severe cold interrupted a good herring fishing, but the next year results were very poor (Forget, 1979). This stock was mentioned again in 1804, 1827 and 1838 (AD 44, J 120). Afterwards, no record of this stock has been found until the end of the 19th century. But, in 1880, herring were so abundant that they were loaded in bulk on ox carts (Le Gall, 1926). The Statistiques des Pêches maritimes reported important yields in 1883, 1894 (1000 t) and 1913 (figure 4). Then the catch decreased with successive peaks following one another at 4 to 6 years intervals. A minimum of 16 t was reached in 1954, after which the landings rose to 1500 t in 1970. Nowadays they are decreasing.

The sardine fishery was confined to within a few miles of the coast. The "chaloupes sardinières" were small, open fishing boats unable to go offshore. Until the second world war, the bulk of the yield was caught with drift nets baited with roe. The fish were only caught if they rose to the bait, and were meshed in the gill nets. Landings consisted essentially of immature fish, caught during their coastwards migration (Le Gall, 1935). In St Jean de Luz, the only harbour where sardines were caught without roe, the fishing begins in late September and ends in March. As one goes northwards, the date at which young sardines appear in coastal water is delayed from April-May at Les Sables d'Olonne to June-July at Lorient or Belle Ile and to August at Douarnenez.

Usually, sardines are not fished to the north of Brest. Most of the yield comes from southern Brittany and Vendée. Nevertheless, a small fishery occasionally develops on the northern coast of Brittany. It is attested in 1726, 1728, 1752, 1761, 1762, 1764 (Duhamel du Monceau; Darsel, 1976; Lemoine et Bourde de la Rogerie, 1902). But sardine disappeared during the first years of the 19th century (Le Gall, 1904). This fishery started again during the 1860s and 1870s (Guillou, 1873; Seilhac, 1903).

To gather quantitative data on this fishery is not easy, due to the dispersed nature of the fishing and its undercapitalisation. The data used here, for the 18th century, were mainly collected in the literature (see References). The sardine import legislation also gives an indication of the relative importance of the annual catch. Usually the landings were adequate for French needs, and imports of the less expensive Spanish sardine were prohibited. But, when a sardine shortage occurred, import of Spanish sardines, or even British pilchards, was allowed. For the 19th century, data from the "Mémoires statistiques" (AN CC5, AD29, AD44, AM Lorient) were also used. Not all the information is in good agreement, and care is needed in its interpretation.

During the last two centuries, the total fishing effort may be approximated by the number of fishing boats (fig. 5b). During the first thirty years of the 18th century the number of sardine

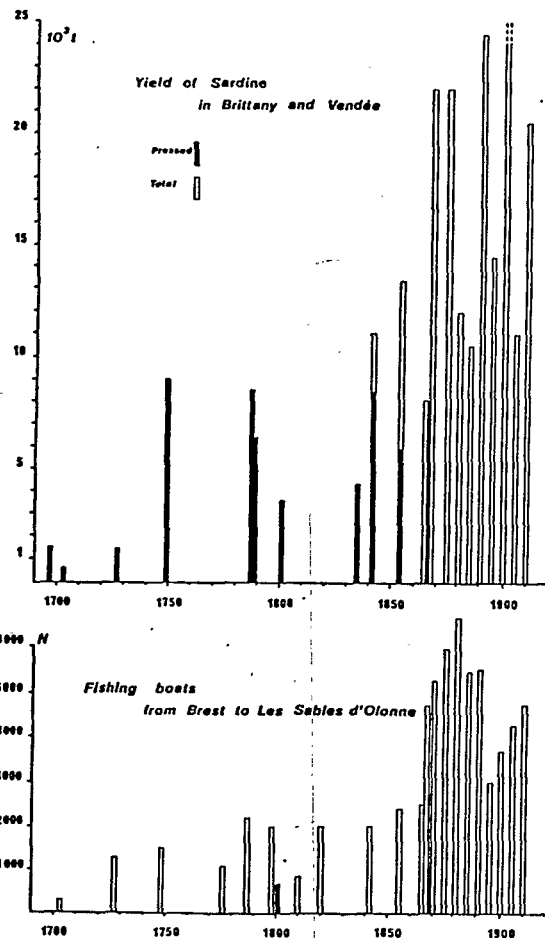


Fig. 5.- (a) Yield of sardine in Brittany and Vendée. Only pressed (i.e. salted) production is known up to 1840. From the literature sources (see references) and the Statistiques des Pêches maritimes.

(b) Total number of fishing boats in south Brittany and Vendée, very close to number of sardine fishing boats (ibid). Black bar: estimated from the number of fishermen (Le Gall, 1904).

fishing boats increased from 300 (Lemoine et Bourde de la Rogerie, 1902) to 1300 (Lemasson du Parc). In 1776 the number given by Duhamel du Monceau was approximately the same; then it increased to about 2200 in 1787 and was still 2000 in 1798 (from Le Gall, 1904). During the years of Révolution and Empire, fishing activity declined abruptly. The number of "chaloupes" ranged from 700 to less than 1000 between 1801 and 1810 (estimated from Le Gall, 1904 and Le Maître, 1977). When peace returned, the number of boats grew quickly to reach 2000 in 1821 (Forget, 1977). It then remained constant for 20 years. There was then a rapid increase: 2416 boats in 1855, 4750 in 1867, 6800 in 1880.

The estimate of the total yield is approximate due to the unstandardized units used and to the restrictions mentioned above. The oldest data record only the number of barrels of salted fish. Unsalted sardines, sold directly were not accounted for and the total catch was very much higher. Three quarters of the landings were pressed in Concarneau in 1834, one third in the Morbihan but only 2% in Le Croisic between 1809 and 1819 (Marie d'Avigneau, 1958). These ratios varied with the local number of presses, and the amount of the annual catch.

During the 18th century, the reported yields of salted sardines rose (fig. 5), and the fishing efficiency (yield / numbers of boats) seemed to improve. Alternatively the number of fish presses increased. During the 19th century, the pre-Revolutionary yield was only reached again by 1840. Then it increased rapidly, due to the setting up of canning factories along the coast (fig. 6).

The publication of the "Statistique des Pêches maritimes" began in 1866. But the sardine catch was not reported in weight units before 1894. So, an equivalence has been computed from the monetary product, according to the sale price fluctuations given by Marie d'Avigneau (1958). This had made it possible to assess the yield in tonnes from 1865 onwards (fig. 7).

During past centuries, sardine shortages can only be discerned if a large fishing effort was exerted. They, therefore appear more dramatic when they take place in the course of a good fishing period. Using the quantitative and qualitative data available, a graph of years of good and bad yields has been attempted (fig. 8). The archival clues used for this purpose are probably subjective references to the preceding yields. An attempt to sum up the long-term trend is also shown (fig. 8).

It appears that sardine crises were already being reported during the eighteenth century. Very bad yields were reported in 1714 (Huetz de Lemp, 1975) and in 1725 (Cadoret, 1912; Le Gall, 1904; Odin, 1894). Between 1730 and 1740, few data were available, probably meaning average results. Then from 1740 to 1757 very good catches were made, while in 1741 and 1755, Breton landings were catastrophic (Audouy, 1969; Buffet, 1972; Cadoret, 1912; Le Gall, 1904; Odin, 1894; Tattevin, 1941). Afterwards, bad

Number of fish canneries

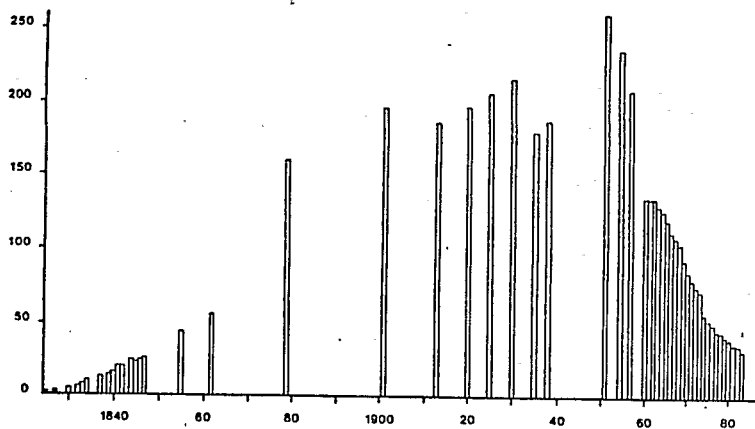


Fig. 6.- Development of the fish canning industry in France. From Marie d'Avigneau (1958) and Gilly (1985)

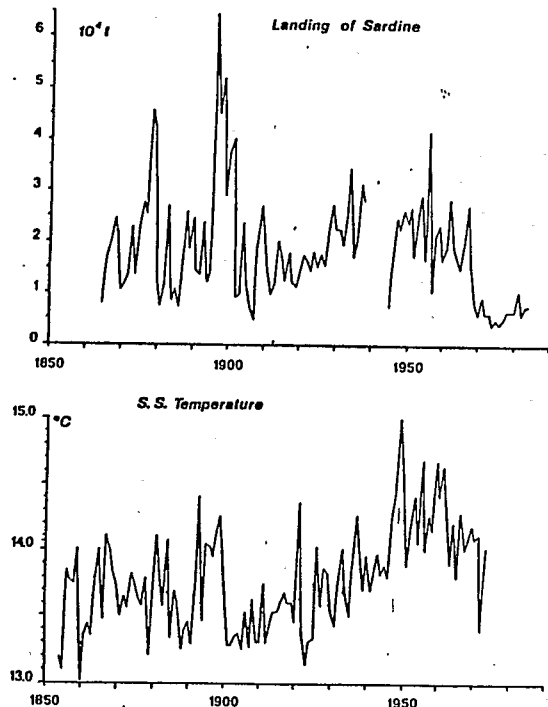


Fig. 7.- (top) Landing of sardine in the Bay of Biscay (mainly south Brittany and Vendée).

264

(bottom) Sea surface temperature of the Bay of Biscay and Celtic Sea - (45-50 N, 5-10 N) in Lamb, 1977

yields were recorded, partly due to the state of war (Ogés, 1964). From 1767 to 1779 average results were observed (Buffet, 1972; Cadoret, 1912; Duhamel du Monceau, Sée, 1925) with some good years in Brittany and also in Vendée (Pougard, 1979; Odin, 1894). After the North America Independence War, several good yields were still recorded. Then, during the Révolution and especially the Empire, the fishing was very poor; poor yields seem to have been more frequent in Brittany than in Vendée (Odin, 1894).

During the two decades following the end of the first Empire, results are rather poor although some good and very good catches were recorded (Odin, 1894). In late 1870s production reached a maximum, when the first severe crisis struck the sardine industry (fig. 7). From 1880 to 1887 the catch was reduced by a factor of 2 to 6. Afterwards, sardines returned, and the best yields occurred between 1888 and 1901. Then, suddenly, landings decreased again, to one quarter to one seventh of their former value. This was the great sardine crisis which ended just before the first world war.

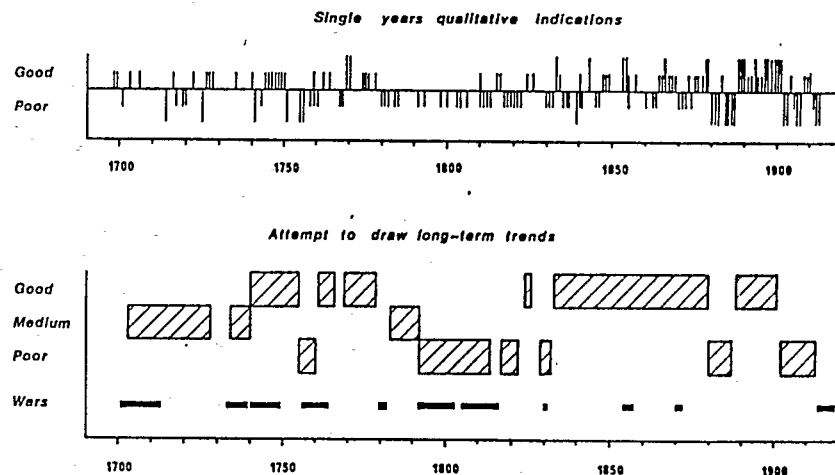


Fig. 8.- Attempt to sum up qualitative clues from the literature, the "Statistique des Pêches" and some archives examined. "Good" or "poor yield" refers to the preceding catches.

According to the records, the bad yields often appear to have been connected to cold years. Wind direction is also thought to have been important. During some of these years of crisis, sardine were sometimes reported as abundant some tens of miles offshore, just out of reach of the small fishing boats. Many fishermen from Brittany looked for fish in the southernmost waters of Vendée. In Brittany, the shortage was not the same in all areas. These indications suggest that availability of sardine is related in part to the sea surface temperatures.

After the first world war the fishing fleet was improved by a progressive motorization, but gill nets were still used. The catches rose until the 1950's, but did not reach the high levels of the late 19th century. From 1956 onwards production has declined, while pelagic trawls replaced drift nets.

#### Discussion

The variation in herring and sardine yields, here described, may have had economic and political or environmental causes.

#### Economics

a) The cost of sardine fishing depended to some extent on the price and availability of bait. The sardine merchants were also importers and sellers of roe (cod eggs). Speculation on this produce made it very expensive and reduced the use the fishermen could make of it. During the Empire wars the naval blockade prevented the arrival of roe from Norway. To some extent fishermen could replace it by a traditional, although prohibited, mixture called "gueldre", prepared from juvenile shrimps and small fishes. During this war period, fishing was strongly reduced due to the lack of young men and to the presence of English warships not far from the coast.

b) The ability of the internal market to absorb the landing of fishes depended on the ability to store fish for several months. So, the catch was probably related to the number of fish presses until 1840, and later to the canneries capacity.

c) The fluctuations of the yield of the southern Brittany herring may be partly explained by momentary increases of effort on this stock, in the cases of sardine shortage during the 18th and 19th centuries or, more recently when herring fishing was banned from northern seas (1978-1982), (fig. 4). But specific replacement due to environmental variations may also explain these events.

#### Climatic influence

It appears unlikely that the stocks described have a constant biomass and that catch fluctuations are related only to variations in fishing effort. The catch variations reflect availability and probably also biomass fluctuations. Both these seem to be related to long term climatic changes. Wyatt (1983) records many changes in the distribution and life history of fish in the north Atlantic Ocean since the 18th century: the most notable seem to have occurred around the beginning of the 19th century, but a partial return to 18th century conditions is observed in the 1870s and striking changes were also linked to the "climatic amelioration" of 1930-1960. These conclusions agree very well with the data here presented. Indirectly they confirm the value of the scarce and biased cues collected during the French Revolution and Empire period.

In the early 18th, as the climate was improving, according to temperatures in Central England, the sardine yields increased and fresh herring landing were replaced by salted ones. From 1750 to 1775, approximately, the cooling, indicated by the English data, allowed a recovery of the herring fisheries. Meanwhile, the Paris temperatures indicate that the cooling was not appreciable farther south. Sardine yields were probably the highest of the century. During the two following decades, the climatic deterioration spread to France. The herring fishery was bountiful and devoted mainly to fresh production. On the contrary, complaints and crises were frequent among sardine fishermen and merchants. During the Révolution and Empire, herring continued to be available, sardines remained accessible with difficulty off the coast of Brittany, but were never missing in Vendée.

Then, from 1810 to 1830, temperatures increased. As peace returned, herring withdrew from the Chanel. The French herring fishery was disorganized until the middle of the 19th century. Sardine yields increased slowly in spite of sporadic crises. The next warming period was longer in duration: 1850 to 1880 approximately. Sardine yields rose quickly as the canning industry grew up. The improved herring fishery mainly produced salted herrings caught in the North Sea.

Then, two cooler periods occurred, approximately in 1880-1890 and 1900-1910. The total herring catch increased during each cool period and fresh landings show two peaks. The fishery extended westwards. At the same time, the two severe sardine crises already described occurred during each of the two major coolings. The maximum yield had taken place during the ten year warming interval (1890-1900). During the 20th century the peak in sardine landing coincided with the secular warming and yields decreased with the general cooling after the 1950s.

Most of the changes in the fish distribution (Wyatt, 1983) coincided with the reversals of climatic trends here described. The Norwegian cod fishery of the 18th century took place far to



the south of its present location. This fishery declined after 1796 and moved farther north. Devold (1963) describing the alternation between Swedish and Norwegian herring periods, reported two time intervals, 1760-1810 and 1880-1920, during which the Swedish fishery was productive. The same was true in the Channel; so, the good Channel herring fishery periods might correspond to the Bohuslan ones.

Large sardines (pilchards) are commonly fished in the western Channel, on the coast of Cornwall (Cushing, 1957). They may also be caught in the eastern Channel, off Boulogne (Le Gall, 1928). More rarely, pilchards are found in the North Sea. Wyatt (1983) reports them off Scotland from the end of the 18th to 1816. In the 1780s and 1790s they were unusually off Yarmouth. The same occurred in 1868 off Harwich and Dungeness, though at that time pilchards were considered as rare to the east of Portland Bill. From 1951 to 1975 some good catches were made in the southern North Sea (Anonyme b, 1952-1976). These data show very different long-term trends from that of the French sardine fishery. Wyatt (1983) already pointed out that the variations of French sardine and Cornish pilchard fisheries are out of phase.

On the contrary, a comparison with large fisheries of sardine since 1905 (Zupanovitch in Cushing, 1982) shows roughly similar trends; except that the catches of Japanese, Californian and Spanish sardines peak some 20 years before those of the French Atlantic and Yugoslavian fisheries. The Californian stock size variations, as revealed by scales in anaerobic sediments (Smith, 1978) show approximately the same two minima (1880 and 1910) as the French fishery. The long-term trends of very distant sardine stocks covary, meaning probably that they depend upon the same climatic factors.

Finally, on the French coast, we can expect that if the long-term climatic trend is one of amelioration, sardine yields will be favoured and the herring fishery will decline the reverse trend will favour herring.

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EL NIÑO RESPONSE OF THE TROPICAL ATLANTIC OCEAN DURING THE 1984 YEAR

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Abstract

In 1984 the Tropical Atlantic Ocean underwent a dramatic reversal and presented conditions that in many respects were similar to El Niño conditions in the Pacific: sea surface temperatures were unusually high, the tradewinds were substantially reduced. Rainfall increased over the normally arid regions of northeastern Brazil and the coastal zone of southwestern Africa, including Angola, as the Intertropical convergence Zone (ITCZ) was displaced equatorward, a feature which also contributed significantly to the persistence into 1984 of the drought in the Sahel.

An unusual eastward current between the equator and 5° S carried warm water into the Gulf of Guinea. Some of this water flowed south eastward along the African coast and suppressed coastal upwelling as far south as Angola and Namibia. The few available long time-series records show that although the seasonal cycle is dominant in the Atlantic, there is considerable variability from year to year. The two previous warm events with comparable amplitudes occurred in 1934 and 1963 when the arid regions of southwestern Africa experienced severe floods, and coastal upwelling was suppressed. This variability is usually associated with the timing of the major feature of the seasonal cycle, the northward movement of the ITCZ. This movement starts abruptly so that the associated intensification of the southeast trades is sudden. Some (cold, dry) years this happens as early as February, some (warm, wet) years as late as June.

A dramatic contrast occurred between 1983 and 1984 over the Tropical Atlantic Ocean in the atmospheric and oceanic circulations, in a very similar way, albeit inverted, as it was over the Pacific Ocean. During 1983 when the atmospheric circulation over the Pacific was experiencing an extraordinary departure from normal with a reversal of the surface tradewinds, the circulation over the Atlantic was in the building-up phase with stronger than usual tradewinds. As the atmospheric circulation over the Pacific returned to normal during 1984, the