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Domestication of the Eurasian Perch (*Perca fluviatilis*)

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Abstract

The farming of percids (Eurasian perch *Perca fluviatilis*, pikeperch *Sander lucioperca*) has progressively become a diversification path of European inland aquaculture in the past 25 years. This required the domestication of wild or pseudowild (coming from polyculture ponds) populations. Considering the history of Eurasian perch, this domestication can be subdivided into four main successive parts: (1) a short initial prospective period (bibliographical analysis, market analysis, etc.), (2) a first experimental period to acquire basic data that notably resulted in the choice of the rearing system and commercial feeds, (3) a second experimental period allowing to get an in-depth knowledge on each of the main phase of the life cycle of this species (control of the life cycle in rearing conditions), and (4) a third experimental period, still ongoing, of optimization of rearing practices. This chapter allows understanding the domestication framework of this species and better understanding the role of different actors in the decision-making. In the future, the farming of this species is likely to rely on a larger diversity of rearing systems; a key issue is to study the interactions between species-rearing system. How different domestication trajectories or paths (intratrajectories variability) will affect global performances of Eurasian perch remains an open question.

Keywords: Eurasian perch, domestication, aquaculture, chronology, major steps, rearing system

1. Introduction

Fish farming is an animal production sector that followed, in the past years, various dynamic paths according to the region considered. For instance, between 1995 and 2015, this sector displayed a strong increase at global scale with a production rising from 14.9 to 51.3 Mt. (+242%), whereas only a slight increase was observed within the European Union countries: from 490,000 to 660,000 tons (+34%). At national level, fish production has decreased from 65,500

tons in 1995 to 44,500 tons in 2005 (–32%) in France, despite its expansion in other countries like Norway. This fact illustrates that the development of this sector depends strongly on territorial contexts. Despite projections indicating the strong increase of aquaculture at global scale up to 2050, much higher than any other animal production sectors, except for poultry production [1, 2], some territories are facing several obstacles. These obstacles include, among others, (i) competition with other economic sectors (fisheries, tourism, agriculture, production of potable water, etc.), for access to land and water resources, (ii) an economical context of free exchange that often results in strong competition with imported products coming from countries with much lower production costs, (iii) policies (environmental and social protection, food safety, etc.) most often perceived as very binding, and (iv) a degraded image of rearing systems and farming products for which sustainability is frequently questioned by societies in developed countries, particularly concerning quality of products, respect of animal welfare, and environmental impacts. All these issues could hamper the development of aquaculture in some developed countries, such as France. In this context, it is hard to conceive that fish farming could increase significantly in those regions. Nevertheless, these territories are heterogeneous and often display a strong historical, cultural (e.g., culinary traditions), and landscape (mountainous or coastal regions, ponds, wetlands, etc.) diversity that results in numerous microterritories with their specific consumption of fish or more exactly very typical products or dishes. This is particularly true for Europe and France. For instance, one might cite the consumption of smoked eel in the Netherlands [3], frying of cyprinids (roach, rudd) in the Valley of Moselle (Luxemburg), tench in the region of Extremadura in Spain, fried carps in the Sundgau in Alsace in France, meager in the southeast French Mediterranean Sea, or Eurasian perch in the countries around the Alps. These small markets rely on a close link between local populations, the history of the territory, and the presence of a specific landscape (e.g., country of ponds) or particular ecosystems (lakes) and the animal species inhabiting these regions. This tight link between consumers and species is obviously the case for the market of Eurasian perch in the Alps region, where consumers often require the presence of the fish skin to clearly observe the alternation of dark and light bands, typical of this species [4]. These are key advantages for this territory that could allow the development of a diversified and resilient aquaculture based on the diversification of the production and the domestication of new fish species, corresponding to a development model that we can call “mosaic aquaculture.” This is in this global context associated with this vision that the domestication of Eurasian perch started in the early 1990s, 25 years ago. The understanding of the initial motivations and the process of domestication realized over this period require first considering the specificities of inland European aquaculture and associated territories.

In Europe (European Union), inland aquaculture only represents 25.3% of the total production [5]. Two main distinct economic sectors exist, salmoniculture (farming of salmonids, chiefly monoculture of rainbow trout (*Oncorhynchus mykiss*) in running waters and pond culture, corresponding to polyculture in ponds with the dominant species being common carp (*Cyprinus carpio*). Thus, logically, the two most consumed fish species in Europe are rainbow trout (second) and common carp (fifth), mainly in Central and Eastern Europe for the latter. The domestication of Eurasian perch started in France with the will to diversify inland aquaculture while respecting the other economic sectors already developed, particularly pond aquaculture. Interestingly, it is important to specify that in France, pond aquaculture is mainly for the

restocking market in link with angling activities: fish are sold alive to river managers (associations of anglers) or private ponds. These markets are both more lucrative and less demanding in terms of personnel and investment. A very small percentage of this aquaculture production is destined to the markets for human consumption.

2. Why choosing Eurasian perch?

The initial choice of Eurasian perch resulted from several points that were taken into account locally, like at the Lorraine territory scale in France. First, at national level, there was at that time the mutual motivation by several stakeholders (producers, policymakers, and developing agencies) to promote and diversify freshwater aquaculture with different incentives, even though the human consumption market was targeted (Table 1). In Lorraine, this dynamism first resulted in one part in the structuring of the inter-profession with the establishment of the Inland Aquaculture Lorraine Sector (Filière Lorraine d’Aquaculture Continentale) in 1987 and on the other part the inception of a new specific university diploma in inland aquaculture, the “Ingénieur-Technologue” DI-T [6–8]. Besides, carnivorous fishes, such as Eurasian perch, pike-perch *Sander lucioperca*, or pike *Esox Lucius*, are and remain both the most appreciated species by anglers and consumers who know them, particularly in Western Europe (except salmonids). Third, a survey realized at the European scale revealed that in some territories (Eastern France, Switzerland, and Northern Italia), this species was widely consumed in various forms (whole fish, fillets, etc.) and at different sizes (Table 2) [9], and they exist a niche market relatively large such as in Switzerland where it was estimated at about 4000 tons of fillets per year with a supply essentially ensured by fisheries from large lakes in Central and Northern Europe and Russia [10–11]. Fourth, the production of Eurasian perch in polyculture ponds remains challenging to control, which is less the case for other carnivorous species. So much that in certain French regions (Centre), this species was considered as undesirable by fish farmers because of dwarfing problems often linked to the overabundance of young individuals [11].

Summing up, the domestication of Eurasian perch appeared as a good compromise for several reasons: (1) a diversification of aquaculture production targeting the human consumption market by valuing a native species known by consumers and benefiting from a good image

Species	Territories	Initial will	Current production in France
Black bass <i>Micropterus salmoides</i>	South-West	Angling, human consumption	Negligible
Siberian sturgeon <i>Acipenser baeri</i>	Aquitaine	To preserve another sturgeon species (<i>A. sturio</i>)	17 farms, third global producer of caviar
Eurasian perch <i>Perca fluviatilis</i>	Lorraine, Rhône-Alpes	Human consumption	100 tons, three perch farms
Wels <i>Silurus glanis</i>	Centre, Languedoc	Human consumption	Negligible

Table 1. Trials of diversification and domestication of new fish species in inland aquaculture in metropolitan France during the last decades of the twentieth century.

Countries	Production/exploited ecosystems	Valorization
Germany	Fisheries (large lakes, rivers, Baltic Sea)	Angling, exportation, weak human consumption
Austria	Fisheries (Constance Lake)	Exportation, human consumption
Belgium	Fisheries in rivers, polyculture in ponds	Angling
Bulgaria	Fisheries in rivers or in reservoirs	Angling, human consumption
Denmark	Fisheries in lakes or estuaries	Angling, exportation
Finland	Fisheries in Baltic Sea and inland waters	Angling, strong human consumption
France	Fisheries in lakes and rivers	Angling, strong human consumption (East)
Great Britain	Fisheries in lakes and rivers	Angling
Hungary	Fisheries in lakes and rivers	Angling
Ireland	Lough Neagh	Exportation
Luxemburg	Fisheries in rivers	Angling, weakly consumed
Norway	Fisheries in inland waters of East, South, and North-East	Angling, exportation, human consumption
Netherlands	Fisheries in IJsselmeer lakes and inland waters	Angling, weak human consumption
Baltic countries	Fisheries in lakes	Exportation
Poland	Fisheries in inland waters (Swinoujście region)	Angling, exportation
Czech Republic and Slovakia	Fisheries in the Danube River and other rivers	Angling, human consumption
Romania	Fisheries in ponds, in the Danube River, Razelm Lake	Angling, human consumption
Serbia and Macedonia	Fisheries in the Danube River and lakes (Dojran Lake)	Human consumption
Sweden	Fisheries in the Baltic Sea	Angling, exportation, human consumption
Switzerland	Fisheries in lake	Angling, strong human consumption

Table 2. Interest for Eurasian perch according to European countries, survey realized in 1993 [9].

and an established market niche and (2) the development of a new activity that did not harm other traditional activities of the sector (no competition). Initially, this project of diversification aimed at developing a complementary activity for pond fish farmers. Besides, linking to the survey realized [9], a possible competition with capture fisheries coming from Eastern and Central Europe as well as Scandinavia was highlighted; yet, surveyed persons stated that the capture levels were highly variable from one year to another, product quality (filleting yield) also strongly varied (effect of reproductive cycle), and supply period of market was stopped during the spawning season in spring. Consequently, all these facts confirmed the possibilities to develop an aquaculture of Eurasian perch targeting a regular production of fresh fillets with a constant and high quality.

3. Acquiring knowledge on the biology of *P. fluviatilis* and *P. flavescens*

At the end of the 1980s and beginning of the 1990s, an in-depth analysis of the available literature on the biology of Eurasian perch and a North American close species, the yellow perch *P. flavescens*, was performed to better evaluate potentialities of this species. We first analyzed general articles as well as book chapters [12–22]. Then, we considered more specific studies focusing on the characteristics of populations inhabiting particular aquatic areas [13–27]. In the meantime, because some farming trials were already performed on yellow perch in the United States (large lake areas), a similar approach was realized aiming at establishing a synthesis of knowledge acquired on the zootechny of this sister species [28–38]. At this period, yellow perch was considered as the reference to promote the farming of Eurasian perch. This choice was reinforced by the fact that questioning about the rearing systems (ponds or recirculated systems) was similar. Based on these bibliographical analyses, preliminary thoughts resulted in the emergence of farming possibilities in Europe [39], and perciculture (i.e., farming of perch) was proposed as a possible way to diversity inland aquaculture in Europe [40].

3.1. Study of the life cycle of perch in natural conditions, first zootechnical trials, and choice of the rearing system

During the 1990s, researches were undertaken to first better know the life cycle of the species in local aquatic ecosystems, mainly in the Mirgenbach reservoir and Lindre ponds (Moselle, France), and second to determine the potential of this species at different stages (larval rearing, on-growing). The choice of the Mirgenbach was linked to the fact that this reservoir presents heated waters due to the nuclear power plant of Cattenom and could potentially present thermic conditions more favorable for the growth of perch, in the perspective of a future economic development. These field studies allowed describing the feeding regime, growth (relation size-weight), composition of the main tissues (muscles, gonads, liver, viscera), as well as the reproductive cycle [27, 41–44]. These data constituted the frame of reference and brought the basis for future experimentations, such as the control of the reproductive cycle. In parallel to these descriptive studies, first trials of acclimatization were realized using perch sampled at different development stages in natural conditions (e.g., egg ribbons mainly from the Lemane Lake, INRA Thonon-les-Bains, Haute-Savoie, France), polyculture ponds (young perch of 4–20 g for Lorraine fish farm ponds), or rivers (eggs ribbons from Meuse). The acclimatization of young perch, either juveniles or sexually mature individuals, with diverse features from one year to another, was closely linked to the will to value stocks of fish often very abundant during fall and spring pond fisheries and displaying a low market value. Based on the works performed on the yellow perch [32, 34, 36], several weaning protocols were tested using feeds or diverse raw materials (beef liver, frozen plankton, dried or hydrated formulated feeds) [45]. Because of (i) very high mortality rate (40–60% in 2 months) linked to food refusal, development of pathologies caused by *Aeromonas hydrophila* and cannibalism, (ii) high variability of qualities of the different batches of fishes received (juveniles or mature fishes, sizes, more or less lean fish, etc.), and (iii) difficulty of weaning protocols, this way of developing perciculture was rapidly stopped. Nevertheless, it was

maintained during few years to produce the biological material to realize growth trials and produce breeders [46]. This work allowed conducting a thinking on the choice of the rearing system, which was the most adapted to perciculture. If the production of juveniles could be realized in small ponds following extensive or semi-intensive methods [47], the on-growing phase was rapidly focused on rearing systems in controlled conditions, which allow higher production levels and a rationalization of rearing conditions to guarantee a reproducibility of performances and the development of the sector. Thus, on-growing trials were performed in floating cages (Lindre ponds, Lake of Féronval) and in recirculated aquaculture system (RAS) in Belgium and France. In this comparative approach of the possible potentialities by different rearing systems, it was demonstrated that similar specific growth rates were obtained in cages and RAS, but survival rates, feed conversion rates, and the homogeneity of individual weights were better in RAS [45, 48, 49]. It also appeared that perches farmed in cages had started a reproductive cycle: females and males captured in September (40–70 g) displayed gonadosomatic indexes of 2.4 and 7.1%, respectively, whereas they were constant and low in RAS (<0.5, sexual resting) [45, 48]. Yet, the development of gonads at such a low weight, lower than the market weight targeted (80–120 g), constituted a problem for maintaining optimal growth performances. These zootechnical trials also demonstrated that this species was very sensitive to pathogens, among which are parasites such as *Heteropolaria* sp., a protozoaire [50, 51], or bacteria, such as *Aeromonas sobria* [52]. This sensitivity of this species led to the shutdown of the project of the enterprise Perlac SA located in the Lake Neuchâtel in Switzerland. The sensitivity of this species to external parasites, such as *Dactylogyrus* or *Costias*, was confirmed during the first rearing trials performed by the society Lucas Perches created in 2001 in France [53]. At this period, this society used the water from a small river “La petite seille” to decrease the water temperature coming from a geothermal forage used by the society. At last, a strong individual growth heterogeneity was observed during trials [50]. All these experiences realized in Belgium, France, and Switzerland resulted in the choice of RAS as the most adapted rearing system for the development of perciculture [54, 55]. This choice was confirmed by technical choices operated by the first perch farms, Percitech in Switzerland (society created in 1994) and Lucas Perches in France (created in 2002) (Figure 1). Since then, researches exclusively focus on this rearing system using diets for trout or sea bass mainly.

3.2. Control of the life cycle of Eurasian perch for the development of perciculture in RAS

Once the rearing system selected (intensive monoculture in RAS for the production of fillet for human consumption), diverse researches were performed in order to control the life cycle of the species in indoor conditions. They include the control of the reproductive cycle, the development of larval rearing protocols, the determination of nutritional needs, the optimization of growth performances, the control of quality of products, and first trials of genetic improvement. These researches were funded by both national (mainly in Belgium and France) and international, chiefly thanks to the European Union (FAIR-CT96-1572 1996-1998, FAIR-CT98-9241 1998-1999, Σ! 2321 ACRAPEP/ANVAR A0011134L 2001-2004, COOP-CT-2004-512629-PERCATECH 2004-2006) programs.

Figure 1. Timeline displaying the key phases of the domestication of Eurasian perch with from one hand the main knowledge acquired and the decisive decision taken (above the bar) and from the other hand the major events that occurred (below the bar) over the period 1990–2018.

3.3. Control of the reproduction

Even though the market for the perch fillet remains seasonal in the traditional consumption market (March–October), the development of an intensive monoculture in RAS required a complete control of the reproductive cycle in order to obtain out-of-season spawning and not only rely on the single annual reproduction occurring in spring [41–43, 56]. A first research axis focused on the environmental control of the reproductive cycle. A preliminary test demonstrated the possibility of controlling the reproductive cycle by manipulating both water temperature and duration of photoperiod [57]. Thereafter, these researches allowed disentangling the respective roles of water temperature variations and duration of photophase by distinguishing the different phases of a reproductive cycle: induction, vitellogenesis, and final steps of the cycle [58–66]. All these works allowed developing a reliable protocol for the induction of out-of-season spawning close to 100% [67]. This program is now routinely applied in farm conditions; it allowed the realization of 2–12 reproductive cycles per year with different batches of breeders managed in delayed conditions. If the temperature variations and the duration of photoperiod drive the timing of the successive steps of the reproductive cycle (determining factors), other factors can modulate the quality of reproductive performances observed. For example, the feeding strategy is very important, and thus the nutritional needs of breeders were specified [68, 69]. In fact, numerous rearing factors, including environmental, nutritional, and populational, can act on breeders and influence their reproductive performances; multifactorial approaches must be used to optimize rearing conditions and secure performances [70, 71].

Complementary to the control of reproductive cycle for the induction of out-of-season spawning, additional protocols based on hormonal injection were developed to synchronize spawning during the reproductive season [72–77]. They were based on previous works performed on the yellow perch [78–80]. The application of hormonal injections is now facilitated by the use of a classification method of oocyte stage maturation in preovulatory period [81]. At last, reliable protocols for collecting gametes (spermatozoa, oocytes) and artificial reproduction are also now available [82].

3.4. Larval rearing

Initially, trials of larval rearing were performed with spawning collected in various aquatic areas. Like for on-growing trials, several ways were initially prospected to promote the production of weaned juveniles: (1) an extensive production in small ponds with an *ex situ* weaning in tanks, (2) a semi-intensive production in mesocosms, and (3) an intensive production in RAS [83]. Even though few fish farms used the methods of mesocosms to produce the juveniles, particularly in Ireland, this is the intensive rearing in RAS that is mainly used nowadays. The first works aimed at optimizing the abiotic environment of farming (light intensity, duration of photophase, color of tank walls) and feeding protocols [84–87]. Initially, particular attention was paid to the use or not and the choice of live prey for larval rearing. The first protocols that have been developed used rotifers [88] or nauplii of *Artemia* spp. of various sizes [84, 87, 89–91]. The feeding transition (weaning = change from a feeding based on live prey to a commercial formulated diet) was soon questioned [92]. Very rapidly, major issues appeared: first, a high growth heterogeneity with a strong intra-cohort cannibalism rate [93–95] and second, the onset of developmental anomalies (malformations of skeleton and lordosis) with notably low inflation rate of the swim bladder [96–98].

The very strong impact of cannibalism within the first weeks of rearing was rapidly confirmed during the first commercial production [53]. Up to now, the strategy adopted by fish farmers to reduce cannibalism relies on frequent sorting (each week or 2 weeks) to maintain homogeneous batches during the nursery period and early weeks of on-growing. At that level, the results obtained by Mandiki et al. [99] suggested that they are natural populations less aggressive than others are, when they are placed in rearing conditions. Consequently it could be interesting to evaluate the intraspecific variability of wild populations (search for more docile populations). Concerning the problems of the inflation of the swim bladder and developmental anomalies often linked to the first point, they are mainly related to larval rearing conditions [100]. An improvement of rearing conditions associated with a high level of prophylaxis allowed increasing inflation rates and reduced malformation rates. In order to avoid the on-growing of individuals without swim bladder, protocols of sorting, based on practices realized in marine fish farming, were developed [101, 102]. Today, perch farms with well-conceived and seriously managed hatchery-nursery produce regular batches of 0.5 up to 1 million of weaned juveniles. However, developmental anomalies remain regularly observed in farms [103]. It is important to specify that the publication of a developmental table for the embryo-larvae corresponding to a normal development constitutes a major tool to identify the causes of common developmental anomalies) [104].

3.5. On-growing, nutritional needs

Once fry were available, trials on pre-on-growing and on-growing were realized in order to determine from one part the optimal conditions of growth and on the other part the potential of this species. It was first demonstrated that this species has a diurnal feeding activity [105]; the application of photoperiod with a long photophase stimulates growth and inhibits gonadal development [106]. First rearing trials had also demonstrated the gregarious behavior of this species (schooling behavior) and its ability to feed on pellets [46]. At this period, feeds for rainbow trout or sea bass were distributed to perch; feed conversion rates of 1.0–1.5 were registered according to the ration rate applied [49, 106–108]. High survival rates were also obtained (>80%).

Once these favorable prerequisites were established (gregarious behavior, sufficient survival, acceptability of artificial feeds, correct alimentary conversion rate, etc.), more dedicated researches were realized on the effects of both major abiotic and biotic factors on growth. Thus, it was demonstrated that the optimal temperature for growth was 22–24°C [107]. Thereafter, complementary works allowed specifying the effects of the rearing environment (tank wall color, light intensity, manipulations) on the ingested feed and growth [109–110]. The effects of rearing conditions on the physiological state of fish were also studied; perch appeared as very sensitive to both poor conditions and manipulations [111, 112]. At the feeding level, ration table for maintenance and optimal and maximal growth according to physiological stages were determined [107, 108, 113, 114]. Then, nutritional needs were progressively determined to promote the emergence of a feed for percids once the volume of production would be large enough. Thus, the nutritional requirements in proteins, lipids, and some additives, such as oxidative as ethoxyquin, were specified [89, 115–118]. These studies allowed defining that a feed for perch should contain 43–50% of proteins, 13–18% of lipids, and 10–15% of glucids [119].

3.6. Quality of products

The domestication of species for the human consumption market requires knowing and controlling the quality of products (whole fish, fillet). Thus, very early, once the first zootechnical trials were completed, the chemical composition of the tissue of perch, and notably muscle, was analyzed [41, 120]. One major goal was the production of constant quality fillet to consumers, similar to the wild fillet coming from the lake. Researches were started from one part to understand the natural variability of organoleptic properties of the perch fillet according to the origin of captures and, on the other part, to identify the determinants of this quality. Importantly, the quality of a product is a vague and complex notion that depends on nutritional, technological, sensorial, and sanitary features. Thus, features of perch coming from different regions (Geneva Lake, Rhine estuary) were compared among themselves and to perch obtained from RAS [121, 122]. It was found that first the quality of products was highly variable according to the natural environment studied and second that farming factors (feeds, rearing densities, etc.) strongly impacted the properties of farmed perch [123, 124]. In fact, the control of the quality of products (flesh or whole fish), over the course of domestication, is multifactorial [125, 126].

3.7. Manipulation of sex and ploidy: genetic management of domesticated populations

The Eurasian perch displays a sexual dimorphism of growth in favor of females [107, 108]; thus, the production of monosex female populations has rapidly appeared as a solution to reduce growth heterogeneity and increase growth performances. Hence, protocols (hormonal treatment with 17α -methyltestosterone) were developed for the production of homogametic males or neomales (XX) [127], with a sperm quality similar to heterogametic males [128]. Once produced and mature, those neomales were bred with normal females (XX) allowing the production of 100% females, for which growth improvements were observed after 7 months of rearing in RAS at 23°C [129]. In a complementary study, trials of production of 100% female populations were also realized by gynogenesis using spermatozoa inactivated by UV radiation [130]. However, due to the low survival rates as well as insufficient growth performances, this method is rarely used [129].

A second path, triploidization, was also studied in order to produce sterile animals. This path also appeared as very important because Eurasian perch is a species that can start a reproductive cycle before reaching market size. It is possible to capture in natural habitats (ponds) sexually mature females and males as such low weights as 10–20 g, even lower for males. As for other species reared in fish farming (salmonids), protocols based on thermal or pressure shocks were also developed to produce triploid perch [131].

With the development of perch farms (7–8 farms localized in Germany, France, Ireland, and Switzerland) and the increase of production in RAS (estimated between 500 and 800 tons per year), first thinking on the necessity to develop selective breeding programs emerged, mainly to improve growth performances and decrease production costs. Yet, up to now, no true selective breeding programs exist, even though basic genetic knowledge was acquired to develop them. Studies have notably allowed to characterize the genetic variability of wild perch, very often used as founding populations of current farmed stocks [132–133] and stocks of domesticated breeders currently present in perch farms [134]. These studies have demonstrated that the available stocks of domesticated perch in farms were (i) sufficiently genetically variable to allow developing selective genetic programs (lack of consanguinity) and (ii) often genetically distant from the origin populations (Alpine lakes) presumably assumed by fish farmers.

4. Dissemination and knowledge transfer

The domestication of a species requires the onset of periods of exchanges between all stakeholders of the sector (**Figure 1**), notably to allow transfer of expertise and co-elaboration of projects based on the identification of priorities and major bottlenecks. Concerning Eurasian perch, very rapidly, the few research laboratories implied in this species cooperated and organized scientific seminars at different scales to allow sharing new knowledge. The meetings organized at the transatlantic level (Canada, USA, and Europe) aimed first at sharing works performed on Eurasian and yellow perch. Some of these events (Namur, 2008; Nancy, 2014) had for main objective exchanges between the socioeconomic stakeholders of the sector (fish

farmers, designer of fish farms, traders in aquatic products, etc.). Progressively, knowledge was compiled in more and more comprehensive book [135, 136]. Obviously, this diffusion of knowledge and co-construction also occurred at local, regional, and national scales. In France, for instance, an informal group of exchanges, entitled “National group of pond carnivorous fish,” often met in the beginning of the 1990s to discuss experience on various species (Wels, pikeperch, black-bass, and perch) that were the subject of diversification [137–140]. At the regional level, in Lorraine, the “Filière Lorraine d’Aquaculture Continentale (FLAC)” supports diverse zootechnical trials and, therefore, actively contributes to the emergence of perch farms on this territory. Later a similar initiative was taken in other regions from other countries, like in Ireland [141].

5. Conclusion

The domestication of Eurasian perch was initially based on local issues (niche market, development of activities and jobs in rural environments). This domestication occurred in a few main steps: (1) socioeconomic analysis of the market, (2) first zootechnical trials and choice of the major rearing system (RAS), and (3) acquisition of in-depth knowledge on the successive stages of the production cycle (control of the reproductive cycle and reproduction, control of the larval rearing, on-growing, and quality of products) (**Figure 1**). It is important to highlight that the first two steps strongly considered the knowledge previously acquired on a close species, the yellow perch. Today, the Eurasian perch is considered at the level 4 of domestication, which means that the entire life cycle is closed in captivity without any wild inputs but no selective breeding programs is applied [142].

Even though the first experimental trials were initiated at the beginning of the 1990s, the first perch farm (SARL Lucas Perches) created within the European Union was located in 2002 as a pilot enterprise. Importantly in Switzerland, a perch farm, Percitech, was created much earlier in 1994. About 20 years later, numerous projects were launched, some with very high expectations (e.g., FjordFresh Holding S/A in Estonia), in numerous European countries; 10 of these enterprises truly developed a commercial activity. Today, most perch farms pursue their activities; only few, mainly in Ireland (country where perch is not consumed), have stopped their activity. The investors that initially believed in this species were not issued from the aquaculture sector and discovered it. Sometimes, it corresponds to industrials that succeeded in other sectors and wants to diversify their activities. This initial distance from the aquaculture sector constitutes one of the reasons of the slow development of perciculture. Learning requires time. Without doubt, the domestication of Eurasian perch was and remained a particular human adventure, where the link between the species and humans is visible at different levels and various forms.

In terms of perspective, one can expect that this young sector will pursue its development first based on current farms, whose economic viability remains to be demonstrated and second in link with the emergence of new projects and expansion of the market toward new consumers. This new development could imply the production of both pikeperch and perch within the same farms. To support this development, it is imperative to reduce production costs, high

in RAS, and secure current stocks. The decrease of cost production will require in priority the onset of selective breeding programs and genetic improvements, a standardization and rationalization of rearing protocols (e.g., percid feeds, ration tables, etc.) and a reduction of investment levels for the development of new perch farms. For some, the development of a monoculture of perch in ponds could be the solution because it will allow a strong decrease in production cost. On the security side, it is important to (i) better know pathologies associated with this species, notably virus, among which some might represent a major risk for percids [143] and (ii) specify the effects of the domestication process on rearing performances of this species. As any other domesticated species, biological responses and performances of perch are modified by the domesticating environment specific to the rearing system chosen and associated rearing practices. Thus, preliminary results indicated that reproductive performances [144, 145] and its sensitivity to stress and immune system [146–150] depend on farm conditions. In the future, the domesticating context (**Figure 2**) could strongly vary according to local environment, which could lead fish farmer to choose different rearing systems and to target different markets. Once this main choice realized (context and domesticating direction fixed), secondary choices will define the trajectory of domestication that will result in physiological stage capture in nature, of the dynamic of transition (progressive or sharp) and cultural practices used, practices that could evolve over time with different dynamics. This complexity is reinforced by the fact that a population engaged in a specific domesticating context could change into another context because of a modification in the project, as was the case for perch reared in polyculture ponds, then weaned, and grown in cages or RAS (**Figure 2**). This diversity of directions and domesticating trajectories should lead to different evolutions (behavior, stress physiology, reproduction, etc.) variable from a context to another. These evolutions could even lead fish farmers to reconsider the initial choice of founding populations, given the enormous genetic diversity available in wild populations [4].

Figure 2. Diagram explaining the different domestication frameworks and pressures encountered by Eurasian perch during current farming trials (F: Framework, T: Trajectory, P: Path).

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