Endocrinology and fish culture

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Abstract

In the current practice of fish culture the use of hormones is mainly limited to the field of reproduction, and more precisely to induce or synchronize ovulation and stimulate spermiation. The practice of pituitary homogenates injection (called hypophysation) which started in the early 1930’s has allowed spectacular developments in the culture of some cyprinid species, especially in China, India and Europe. HCG has been used successfully in a limited number of species and LHRH-A, often associated with antidopaminergic compounds, started to be used in some species, especially cyprinids, on a commercial scale. Sex steroids are now commonly used to reverse the sex of some species in salmonids, cyprinids, tilapias. Due to legal restriction and consumer opposition, the tendency is to limit the use of steroids, especially in fish which are later offered to consumption. GH, which significantly stimulates growth and reduces the food conversion rate in laboratory experiments, will possibly be used on a large scale in fish farms. Endocrinology has considerably increased the knowledge of the mechanisms controlling some physiological functions; this has allowed the identification of sensitive phases in fish in captivity, and helps in the management and the process of domestication (most of the cultured fish species have been taken form the wild recently).

Introduction

Fish farming is fast becoming a major activity in the field of aquatic living resources; its production and yields compose nearly 10% of the total catch from the seas, and it appears as a complementary activity to fishing in producing fish whose natural stocks are small, such as salmonids, either for direct consumption or for stocking (sea and lake ranching). Numerous species are beginning to be cultured and there is a need for reliable techniques of breeding and rearing with low production costs. Endocrinology, as other fields of research, plays an important role in determining new breeding techniques or improving existing ones. The field contributes to fish farming by providing a hormone supply to fish when the endogenous concentration is not sufficient and by furnishing information on the physiological state of the fish and thus determining the optimal treatment or environmental conditions for the fish during the various steps of the production chain. These two aspects will be reviewed in the present paper.

The present impact of endocrinology on the control of fish reproduction

The most spectacular development of endocrinology and the use of hormones in fish farming is ob-
served in the field of reproduction, especially the induction or synchronization of ovulation and the stimulation of spermatiation. To a lesser extent, the initiation and stimulation of oogenesis and spermatogenesis are also practiced to spread gamete availability and fry production throughout the year. Intervention occurs at the pituitary, by the injection of LHRH analogues (LHRH-As), and other factors, and at the gonads by administering gonadotropin and steroids. Various factors controlling the release of LHRH-A at the level of the central nervous system may also be used. At the same time, optimal environmental conditions (social, physical) may be offered to the fish to potentiate the effects of the treatment. Hormones are also used in the various strategies to produce sterile fish in fish farms.

**Induction, synchronization and advancement of oocyte maturation and ovulation**

The most widely-used hormone preparation is pituitary extract (usually crude) in the form of dry powder. This technique, called hypophysation, started in the early 1930’s in Brazil and was aimed at inducing ovulation in fish which did not spawn in captivity. Later, the technique was used in the Soviet Union to spawn sturgeon, and in many other countries, allowing, for instance, the development of cyprinid production after 1950 in China, India and Europe. An exhaustive review of the literature has been presented by Pickford and Atz (1957), Donaldson and Hunter (1983) and Lam (1982). Crude pituitary powder, mainly taken from carp and salmon, is still used widely, but its biological activity is not always known or reported to the fish farmer. Using radioimmunoassays (RIA), Idler et al. (1984) found a concentration of 17, 42 and 90 ng of gonadotropin (GTH)/mg of pituitary powder in three different pools of pituitary taken from carp (Cyprinus carpio). Thus, it appears that doses higher than necessary are often used (3–5 mg/kg of body weight in carp). A dose of 4 mg/kg induces a blood concentration up to 250 ng/ml 24h after injection (Bieniarz et al. 1980), while spontaneous ovulation may occur at 50 ng/ml (Lin et al. 1986).

Brzuska (1987) has shown that the amount of a standard carp pituitary preparation can be lowered to 0.9 mg/kg (two subsequent injections of 0.3 and 0.6 mg/kg 12h apart). Higher doses have to be used in case of heterologous administration because of species specificity. Purified, or partially purified fish gonadotropin of known biological activity is now available commercially, but the cost is high relative to that of crude preparations. The decline of biological activity with time is of concern. According to K. Bieniarz (personal communication), dry carp pituitary loses half its activity within five years. A decline of 25% in 18 months has been reported for SGG100 stored at 35°C in comparison with samples stored at −40°C (Donaldson et al. 1978).

Among steroids, progestogens have been used in laboratory experiments to induce ovulation either in combination with pituitary powder in carp (Jalabert et al. 1977) or alone in rainbow trout (Bry 1981), but this approach has not been extended to commercial practice. Only one mammalian hormone, human chorionic gonadotropin (hCG) is used on a commercial scale to induce ovulation, but its efficiency depends on the species. For instance, it is very potent in the goldfish but not in carp, a closely related species. It has been claimed that hCG generates antibodies in the recipient fish, but this was not found in Clarias gariepinus (Richter et al. 1987) or in carp (Courtois and Billard unpublished data).

The use of LHRH-A is now expanding rapidly. The potency varies according to the structure of the analogues and the recipient species (Crim et al. 1987). Since the early 1970’s, they have been used in China, often in combination with other hormones, in some cyprinid species, and have also been used in salmonids to synchronize ovulation. Since the discovery by Peter and co-workers of a dopaminergic inhibition of GTH secretion in the cyprinid pituitary, the various LHRH-A are combined with dopamine receptor inhibitor, to act on the pituitary when dopamine inhibition is reduced. This combined injection called the Linpe method, is now expanding in China (Peter et al. 1987, 1988). The doses used depend on the species: in the range of 5–10 mg/kg for domperidone, the Janssen anti-