CONTROLLING FISH GAMETOGENESIS PHASE 1:

EARLY GAMETOGENESIS AND THE CRITICAL PERIOD

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Data collection and experiments have concentrated on the relationship between nutrition and reproduction in adult fish, and not with the related problem of evocation of reproduction for the first time. Fish studied have been marine teleosts e.g. winter flounder (*Pleuronectes americanus*) and cod (*Gadus morhua*) of medium size range as adults > 300g - 2kg, which are known to be interannually iteroparous (repeat spawners). The species used are from Northern, cold, marine waters with pronounced seasonal cycles and seem to be quite sensitive to gluts and dearths of food availability.

Two useful findings are first, that not all wild fish such as cod and flounder necessarily reproduce every year as adults, and secondly, this spawning omission can be produced (and reversed for winter flounder, Burton 1991) in the laboratory by feeding manipulation. Another biologically significant result is that nutritional impairment, at a defined, critical period (Burton, in press), early in the normal feeding season for winter flounder females, causes spawning omission whereas starvation later in the feeding season is associated with down-regulation of gamete number. The critical period for winter flounder females is coupled to the normal spawning season, and specifically, for spawners to the actual spawning event. Within a group of flounders from the same population the critical period may vary temporally because individual females can be early or late spawners; it is not known whether this timing is a constant trait from year to year for any one fish but within a sample there can be an 8 week range in the spawning as it occurs in the tanks. Samples from the wild populations also show a range of spawning times within and between years.

For experimental purposes Newfoundland winter flounder are deemed, under seasonal conditions of temperature and photoperiod, to have a critical period extending 4 weeks postspawn. Female flounder which enter the critical period in very good nutritional condition or which are satiation fed during the critical period, tend to develop vitellogenic oocytes for the following year. By either route, good prespawn nutrition or good current feed, it has been found that female flounder (*Pleuronectes americanus*) with relatively high condition factors CF > 1.20 at the end of the critical period will likely be reproductive for the following year, even if subsequent feeding is poor. Fish with low condition factors (for female flounder < 1.00) during or notably at the end of the critical period, will not be reproductive the following year, even if subsequent feeding is very successful.

In early experiments using extended periods of starvation or feeding, resultant non-reproductive females mimicked those found in the wild population during the fall and winter; the most advanced oocytes showed no signs of vitellogenesis or previtellogenesis. However experiments designed to more precisely define the critical period, and experiments using potential LNR (links between nutrient and reproduction, e.g. excitatory or inhibitory amino acids) produced some fish

with intermediate oocyte stages. These intermediate stages are previtellogenesis or endogenous vitellogenesis, which are usually transients for flounder although other fish e.g. cod which have never spawned, judging by fish size and ovarian wall thickness, and have not been experimentally manipulated, can be found in such stages - a possible adolescence.

Injections and oral treatment of female flounder with potential LNR in the critical period have not yet either clearly inhibited or totally stimulated vitellogenesis. In its simplest form an inhibitory link IL would reflect poor nutritional condition and a high plasmatic level would block the seasonally cued oocyte promotion. Alternatively oocyte promotion might need high levels of an excitatory link EL, absent in fish of poor nutrition. The production of intermediate stages by experimental treatments may indicate the need for cooperativity or synergism, either between LNRs or involving a two stage process with one stage dependent on e.g. gonadotropin produced for the recent spawn. Such a situation would require that this hormone was also seasonally evoked even if a fish had not been reproductive for the current spawn, but was going to be switched back on for the next. This is speculative. However the critical period idea is firmer, it is holding up well under experimentation; experiments show it to be temporally very restricted and also very closely tied to the precise spawning time for current spawners.

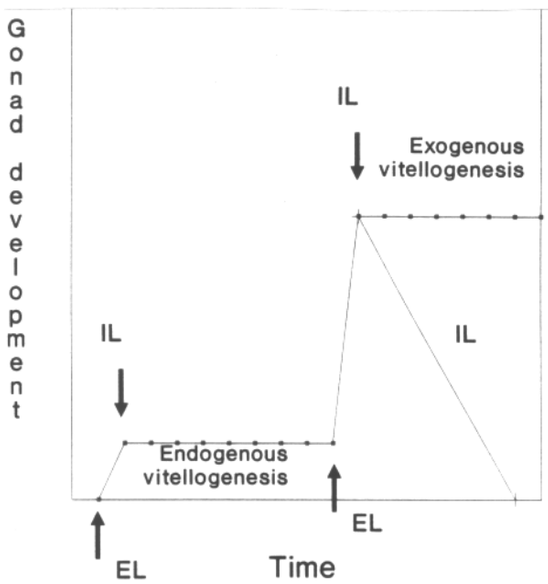

Figure 1
Generalised scheme of action of LNR:
EL = Excitatory Link
IL = Inhibitory Link

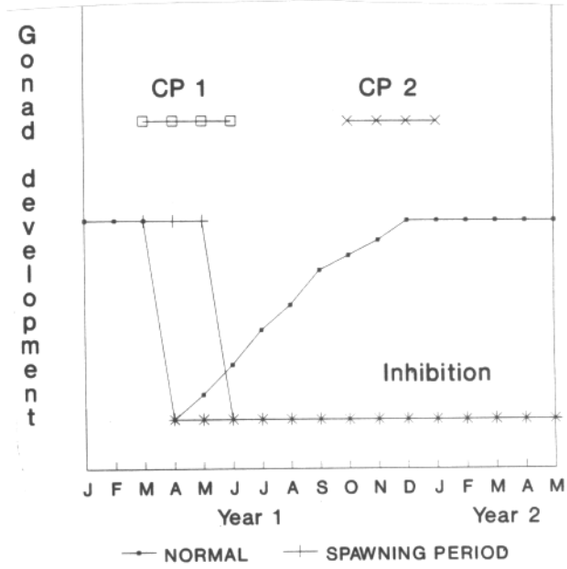

Figure 2
Annual cycle for female winter flounder:
CP1 = Critical Period (known)
CP2 = Down-regulation

Figure 1 is a schematic view of action of LNR at different times for females where either EL or IL could be active in the early phase of oogenesis; oocyte promotion and endogenous vitellogenesis. In Figure 1 there is also a final phase shown with an IL causing down-regulation, but lack of an EL could also be responsible. While (Burton, in press) it has been established for winter flounder that down-regulation of vitellogenic oocytes can occur when feeding is poor in the second half of the feeding season it is not proven that the period of down-regulation ceases (CP2, Fig. 2) before the beginning of the winter fast. Finally although Fig. 1 shows generic IL and EL it is not yet known whether LNR is single or multiple at either CP1 or CP2.

Burton, M.P.M. 1991. Induction and reversal of the non-reproductive state in winter flounder, *Pseudopleuronectes americanus* Walbaum, by manipulating food availability. J. Fish Biol., 39, 909-910.

Burton, M.P.M. In Press. A critical period for nutritional control of early gametogenesis in female winter flounder. J. Zool. Lond.