HORMONE CONTROL OF REPRODUCTION AND SECONDARY SEXUAL CHARACTERS IN FISHES

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AN ABSTRACT

There is great diversity in the reproduction, reproductive habits and in the secondary sexual character of fishes. The various peculiarities in structure and function furnish a rich background for a study of endocrine factors controlling reproduction and the sex accessories.

Sex and sex reversal. Functional protandric hermaphroditism occurs in some fishes (*Sparus*) and many groups furnish instances of non-functional hermaphroditism. In *Xiphophorus helleri* it is reported that males develop from young females by sex reversal. In other cases experiments involving removal of ovaries have sometimes resulted in regeneration of a testis. It is indicated that in some fishes sex is indeterminate, lightly held and easily reversible. It is not surprising, therefore, that gonads are easily modified. Testosterone propionate administered in appropriate doses has caused degeneration of the ovary in *Phoxinus* and several poeciliid fishes and estrogenic hormones have produced a breakdown of the testis or the formation of an ovotestis.

Relation of pituitary hormones to germ cell stimulation and to ovulation. Precocious maturity has been produced in young fishes by implanting the pituitaries of mature fishes in the eye and in other locations. A similar effect has been obtained by grinding pituitaries and injecting them into the peritoneal cavity. Gonadotropic hormones from mammalian sources have also been found to be effective in producing early maturity in fishes. In general, a low degree of group specificity is indicated in the gonadotropic response.

Ovulation occurs in numerous species of fishes when pituitary extracts, ground pituitaries or whole glands are injected or placed in the peritoneal cavities of fishes of the same species. The pituitary hormone of one species is often found to be effective in other species of the same general group but ineffective when administered to a species of a widely separated group. For example, the pituitaries of teleost fishes have been found to be ineffective in cyclostomes.

Hypophysectomy when performed upon a fish undergoing ovulation inhibits completion of the process but ovulation is resumed when pituitary substance is injected into the hypophysectomised fish.

Secondary sex characters. It is convenient to divide secondary sex characters of fishes into two groups. The first includes temporary characters or structures which appear normally only during the breeding season. Pearl organs, nuptial coloration, the mucous glands of the kidneys of the Stickleback and the elongated ovipositor of the Bitterling belong to this group. The second group consists of permanent organs developed at the onset of sexual maturity and include the gonopodia of various fishes in which internal fertilization occurs.

The appearance of temporary secondary sexual characters is inhibited by castration and it is assumed that the characters are controlled at least in part by hormones secreted by the gonads. A better demonstration of the control of secondary sexual characters by estrogenis and androgenic hormones has been furnished by experimentation on the gonopodium of poeciliid fishes. It has been shown that castration inhibits gonopodial development but development is resumed if there is testicular regeneration. A piece of regenerated testis about one fiftieth the size of a normal mature testis furnishes sufficient hormone for the complete development of the gonopodium. Smaller amounts of testicular tissue furnish hormone enough only for the earlier stages of development. When

completely castrated males are treated with an androgenic hormone (ethinyl testosterone) gonopodial development is resumed. When females are treated with ethinyl testosterone the anal fin undergoes a metamorphosis and produces a gonopodium which is atypical but contains the specific characters of the male gonopodium. It has been found that a very dilute solution of the hormone, I mg of the hormone to 110000 cc of water, will produce the earliest stages of metamorphosis but that increasingly greater concentrations are required for the development of each succeeding stage. Reaction to the hormone takes place more rapidly in younger specimens and at higher temperatures. When development has ceased because the temperature level is too low or the concentration of hormone is below that which is required further development may be induced either by raising the temperature or by increasing the concentration of the hormone. It is inferred that in the normal development of the male gonopodium very small quantities of hormone are required to initiate development but that increasing amounts are required for each succeeding stage.