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The Effects of Management Stress on the Endocrine Control of Reproduction of White Sturgeon, *Acipenser transmontanus*

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DISCUSSION

These results demonstrate that the intensity of handling can influence the magnitude of the interrenal response or the increased secretion of plasma cortisol. Significant elevations in plasma cortisol occurred in response to both the minimum and the intense handling treatments. Cortisol secreted from the interrenal gland was higher in concentration in the intensive treatment group in comparison to the minimum treatment group. Previous research in other fish species indicates that fish subjected to lower intensities of stress release less cortisol than do fish subjected to greater amounts of stress. Vijayan and Leatherland (1990) found that as the stocking density was increased, cortisol concentrations increased concommitantly in brook charr, *Salvelinus fontinalis*. Likewise, in chinook salmon, *Oncorhynchus tshawytscha*, a stepwise increase in the plasma cortisol concentration was observed in response to successive disturbances (Barton et al., 1986). Data from this study show that in sturgeon, even minimal handling practices required for sampling blood caused elevated concentrations of plasma cortisol. However, the release of cortisol was significantly higher for the group of sturgeon which were administered additional stressors. This indicates that the intensity of the stress did indeed alter the physiological response of the interrenal gland.

There was no difference in the secretion of plasma stGTH I and stGTH II between the low intensity and the high intensity treatment. It can be concluded, under the conditions outlined in this paper, that varying concentrations of plasma cortisol released due to managment related stress does not effect the degree of LHRHa-induced stGTH I and stGTH II secretion. These results are contrary to those seen in cows where treatment with ACTH or cortisol supressed the gonadotropin, luteinizing hormone (LH), response to GnRHa (Matteri and Moberg, 1982; Li and Wagner, 1983; Padmanabhan et al., 1983). Similarly, stress and/or adrenocorticotropic hormone(ACTH)-induced elevations of corticosteroids were shown to inhibit GnRH-induced secretion of LH in the ram (Matteri et al., 1984) and prevent the preovulatory surge observed in the gilt (Barb et al., 1982).

In contrast to the aforementioned investigations, the results of this paper might be explained by examining relative levels of plasma cortisol. It is possible that both the more intensive and minimal treatment produced a submaximal cortisol response which was not extreme enough to interfere with the gonadal axis. In white sturgeon, however, there are no data which might indicate the maximum possible cortisol concentrations. Maximal concentrations of plasma cortisol observed in this experiment were lower than those seen in other teleosts such as the rainbow trout (Barton, 1980) and chinook salmon (Strange et al., 1978) as well as in mammalian species such as the ram (Matteri et al, 1984). Since a direct comparison of cortisol levels cannot be made between sturgeon and other other species, further experimentation would be required in order to determine the maximum possible secretion of cortisol in response to handling stress.

Another possibility exists as to why the two different concentrations of cortisol do not coincide with the response of the gonadotropins. It may be hypothesized that increased concentrations of cortisol secreted in response to handling do not act alone to suppress pituitary responsiveness to GnRH. Matteri and Moberg (1982) found that the administration of ACTH but not cortisol corresponded with the inhibition of LH secretion in response to exogenous GnRH. This response was also observed in intact and adrenalectomized rams (Fuquay and Moberg, 1983). Although the plasma concentrations of cortisol induced by ACTH were comparable to when injections of cortisol alone were given, injections of cortisol alone did not supress the pituitary LH release in response to LHRHa (Fuquay and Moberg, 1983). Thus, cortisol may act in concert with other neuroendocrine mechanisms, such as ACTH, in order to suppress reproduction in white sturgeon. In order to determine if another neuroendocrine hormone, such as ACTH, plays a significant role in the inhibition of sturgeon reproduction due to stress, further investigations would need to be made.

Not only are the dynamics of stGTH I and II equivalent, the concentrations of stGTH I and II appear very similar as well, with stGTH I increasing only slightly higher than stGTH II 24 hours after the injection of LHRHa. The fact that stGTH I is assumed to be responsible for the initial gonadal development as opposed to stGTH II, which is thought to play a role in the final maturation stage, seems contrary to the results observed in this study. One might expect comparatively lower levels of stGTH I as opposed to stGTH II. However, the functional role of the two gonadotropins and their relative secretion at spermiation have not been adequately studied in sturgeon.

The results of this study indicate that there were no stress related fluctuations in testosterone, nor did stress influence the response of testosterone to LHRHa injection. This is contrary to a study by (Carragher, 1990) where the addition of physiological levels of cortisol were shown to decrease the basal rate of testosterone secretion in rainbow trout. Similarly, plasma testosterone concentrations decreased in response to acute and chronic immobilization, handling, or isolation stress in the rat (Srivastava, 1993; Orr, 1992) and the macaque, *Macaca mulatta* (Norman, 1992) and male tree lizard, *Urosaurus ornatus* (Moore, 1991). However, the response of testosterone to GnRH was attenuated even after a brief period of restraint stress in the male Rhesus monkey, (Hayashi, 1987).

There is evidence in teleost fish such as the amago salmon, *Oncorhynchus rhodurus*, that other steroidal mediators such as 11-Ketotestosterone as well as 17 α, 20β-dihydroxy-4-pregnen-3-one (17 α, 20 β-DP) are involved in male gametogenesis, maturation, and spermiation (Yoshikuni and Najahama, 1991). According to their study, there is evidence which indicates that separate androgens are involved in spermatogenesis and final maturation. In the present study, the analysis of androgens was limited only to the measurement of testosterone. If 11-Ketotestosterone or 17 α, 20β--DP are effective in sturgeon gametogenesis, maturation or spermiation, then data from this study would not have identified the specific dynamics of these hormones. Testosterone concentrations are thought to remain high throughout the spawning period, whereas 11-Ketotestosterone has been shown to increase as maturation occurs, and decrease prior to spermiatiation in other teleosts (Yoshikuni and Najahama, 1991).

It is evident that, although the greater intensity handling stress resulted in a greater degree of cortisol secretion, there was no difference in how either the gonadotropic hormones (stGTH I and stGTH II) or testosterone responded to the injection of LHRHa. This finding is important because it indicates that more extreme handling practices do not readily diminish either the gonadal or the pituitary response to LHRHa as compared to a minimum amount of handling. Implications of this study indicate that hormonal injections of LHRHa can function appropriately regardless of the handling required to carry out spawning in white sturgeon.