THE EFFECT OF MOLT-RELATED CHANGES IN CALCIUM AND MAGNESIUM ON NEUROMUSCULAR TRANSMISSION IN THE LOBSTER (HOMARUS AMERICANUS)

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Previous work has shown that plasma obtained from lobsters in different stages of the molt cycle can alter the size of excitatory junctional potentials (EJPs) recorded from fibers of the claw opener muscle (Schwanke et al., Comp. Biochem. Physiol. 97C: 143-149, 1990). Premolt plasma enhances EJP size relative to lobster saline, while postmolt plasma depresses EJPs. The present investigation was carried out to determine whether known changes in hemolymph levels of Ca^{2+} and Mg^{2+} during the molt cycle might account for the reported plasma effects on neuromuscular transmission. Ca^{2+} concentration rises during premolt to about 20 mM but falls following ecdysis to an average of about 14 mM, while Mg^{2+} levels change from approximately 9 mM at mid-proecdysis to 12 mM during the postmolt period (Mercaldo-Allen, J. Shellfish Res. 10:147-156, 1991). The resultant change in the Ca^{2+}: Mg^{2+} ratio might be expected to alter neuromuscular transmission, a process dependent upon extracellular Ca^{2+} and antagonized by Mg^{2+}.

An isolated claw preparation was used to assess the effects of lobster saline solutions containing altered concentrations of Ca^{2+} and Mg^{2+} to simulate levels found in premolt and postmolt hemolymph. Lobsters were obtained from local sources and housed in running sea water tanks. Claws were obtained by inducing autotomy and the opener muscle was exposed dorsally after removing the overlying exoskeleton. The excitatory motor neuron to the dactyl opener muscle was stimulated in the meropodite while resultant muscle potentials (EJPs) were recorded using standard intracellular techniques. The preparation was continuously perfused with control lobster saline of the following composition (in mM): NaCl 472, KCl 10, $MgCl_2 \cdot 6H_2O$ 7, $CaCl_2$ 16, glucose 11, Tris-maleate 10, pH 7.4 (Meiss & Govind, J. Exp. Biol. 79:99-114, 1979), except during periods of test saline application. Test solutions varied from control in terms of their calcium and magnesium content as follows: premolt saline, $CaCl_2$ 20.5 mM, $MgCl_2$ 9.25 mM; postmolt saline, $CaCl_2$ 14.5 mM, $MgCl_2$ 12.25 mM.

Since EJP amplitudes vary from preparation to preparation (ranging from about 1 to 5 mV), the effects of premolt and postmolt saline were evaluated by considering the change in EJP size during perfusion with test saline vs. control saline. Premolt and postmolt saline varied significantly in their effects on EJP amplitude ($P<0.01$, paired t-test); the former had little effect on EJPs (mean change $\pm$ SEM = 0.03 ± 0.11 mV (n=16), or 4% above control), while the latter caused a consistent depression of EJPs with respect to control saline (mean change $\pm$ SEM = -0.54 ± 0.12 mV (n=16), or 14% below control). Effects were completely reversed upon washout.

These results suggest that the rise in hemolymph Mg^{2+} and fall in Ca^{2+} after ecdysis may cause a slight depression in synaptic transmission at the neuromuscular junction, consistent with the reported effects of postmolt plasma. However, the findings of the present study also indicate that premolt levels of Ca^{2+} and Mg^{2+} are not responsible for the significant enhancement of EJPs by premolt plasma. Hormonal modulation of neuromuscular function thus remains a possibility.

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