Alternans in a Mathematical Crustacean Cardiac Model

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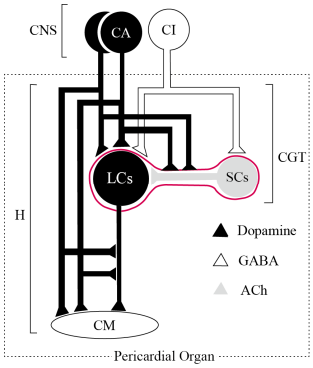
Purpose



CNS Central Nervous System
CA Cardio-accelerator
CI Cardio-inhibitor
LCs Large ganglionic Cells
SCs Small ganglionic Cells
H Heart
CGT Cardiac Ganglionic Trunk
CM Cardiac Muscle

observation of alternans in experiments
↓
a sign of cardiac arrest
↓
reproduction of alternans in a math model
↓
generation mechanism of alternans

Fig. 1: Cardiac nervous system of the hermit crab

Math. model

$$C\frac{dV}{dt} = -I_A - I_{CaT} - I_{CaS} - I_{Kd} - I_{KCa} - I_{Na} - I_l$$

$$I_{CaT} = G_{CaT} m^p h^q (V - E_A)$$

I_A	early outward potassium current
I_{CaT}	transient calcium current
I_{CaS}	persistent calcium current
I_{Kd}	delayed outward potassium current
I_{KCa}	calcium-dependent potassium current
I_{Na}	transient sodium current
I_l	leak current

Results

Numerical calculation

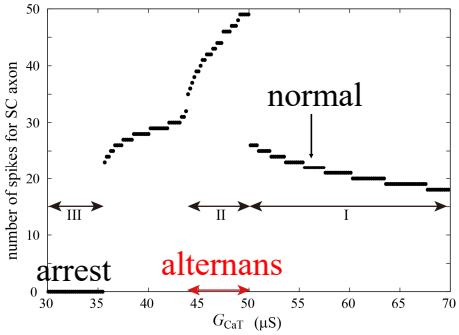


Fig 2 : One-parameter bifurcation diagram.

Animal experiment

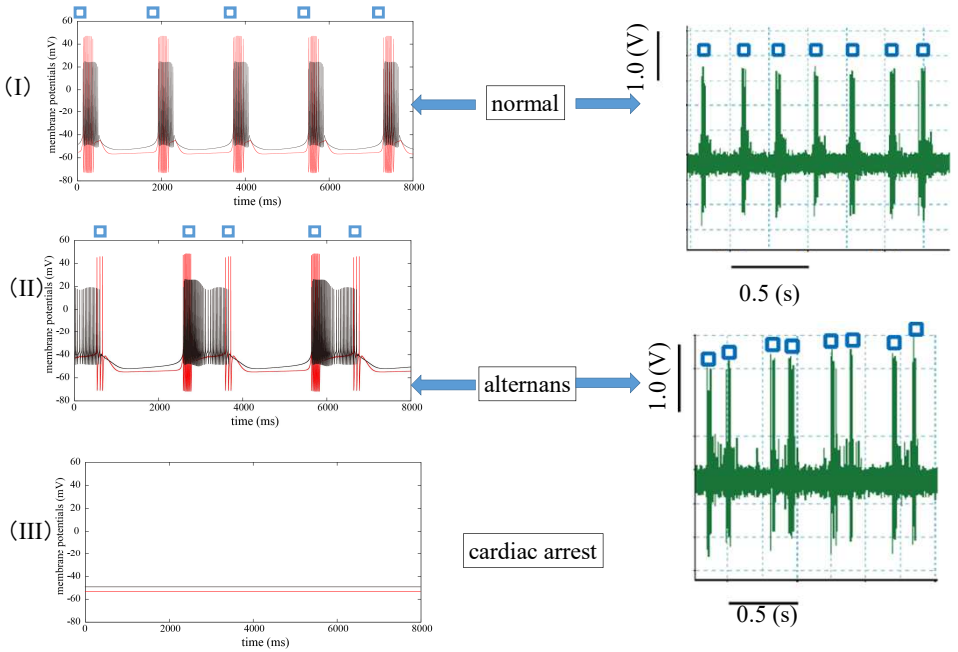


Fig. 3 : Simulation results of membrane potentials of SC (black) and LC (red).

Fig. 4 : Experimental results of membrane potentials of SC (short) and LC (long).

Conclusion

reproduction of cardiac arrest in a math. model → key : transient calcium current