Mesophase Interaction Between Biological Polymers

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Currently the view of charge migration within DNA is that it is too weak to characterize DNA as a conducting wire because of rapid falloff of current with distance (1). It is also possible to look at electronic properties from the view of collective electro-dynamics (2). In this extended view electronic properties are observed within an actual circuit array, under the load of current and voltage and signal form. We therefore searched for conditions of physiologic association for DNA and other biopolymers in order to assess electronic behavior. We found a trio of molecular species which illustrates this interactive principle: prothrombin, hyaluronic acid, and DNA. Prothrombin is heavily studied for its crystal structure (3), but its liquid crystal form is not reported (unlike DNA (4)). If a small amount of prothrombin (ICN) is dissolved in water and allowed to dry on a glass slide, its continuous mesophase array is visible with 300X phase microscopy (Fig.1). This pleasing and varied floral pattern is converted to parallel branches when .5% (w/v) aqueous prothrombin is mixed with an equal aliquot of sodium hyaluronic acid (HA)(Sigma) before drying(Fig.2). If DNA (Sigma-ct) solution is similarly included along with prothrombin and HA, the prothrombin pattern is converted to a new pattern of radial symmetry (Fig.3),a long distance interaction. This DNA effect on prothrombin-HA can be partly mimicked by exposing the drying slide to an electromagnet, an inductive Freedericks transition (5) (Fig.4). Effects of carcinogens such as Ni^{+3} (Fig.5) or tobacco smoke (Fig.6), are observed on the aqueous mixture of prothrombin and HA - the liquid crystal patterns are destroyed.

We reported that HA supports pseudoinductance in DNA exposed to a corrosion stream of mercury ions(6). We also proposed the interaction is a mutual inductance similar to that of twisted wires or coaxial cable. The liquid crystal interactions further support flux coupling of HA with biopolymers. Therefore weak currents such as those in DNA and prothrombin can be conserved, reflected,and transmitted from polymer to polymer by the cooperative electronic properties of HA. This interaction of paired linear polymers is interpretable in multiple ways : twisted pairs, coaxial cable, waveguide, waveguide matrix, or dielectric resonance(7).Specificity of HA may reside in steric association of the polymers, and the dielectric constant (K), which at fixed frequency imposes dimensional requisites (7):

$$\textbf{Resonance Diameter} = K^{-1/2}$$

Conclusion : The prothrombin mesophase shows symmetry shifts from HA, or DNA or magnetic field. The symmetry structure is destroyed by carcinogens. These interactions warrant further study.

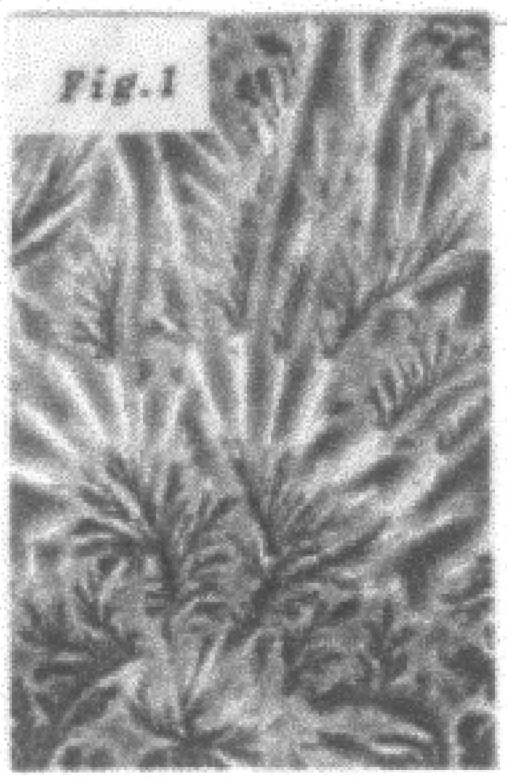
Fig.1

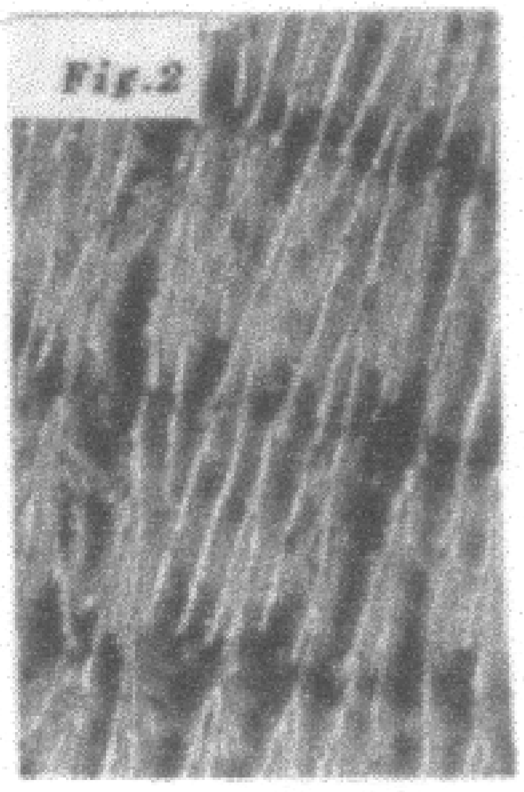
Fig.2

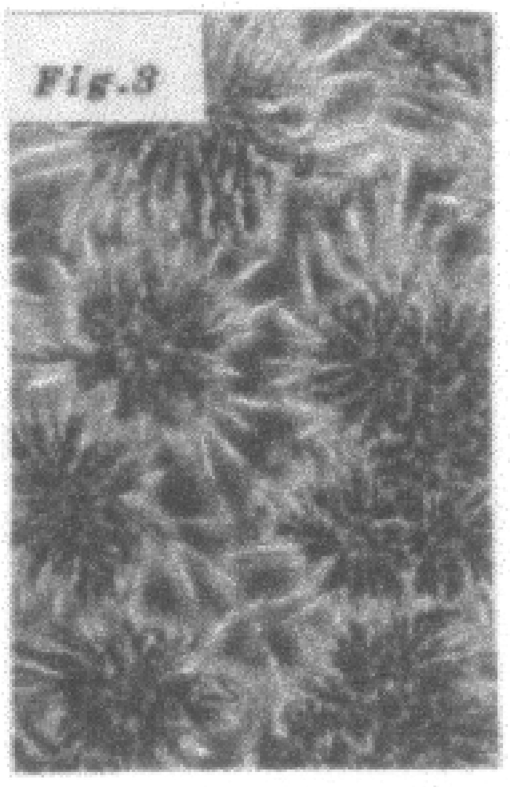
Fig.3

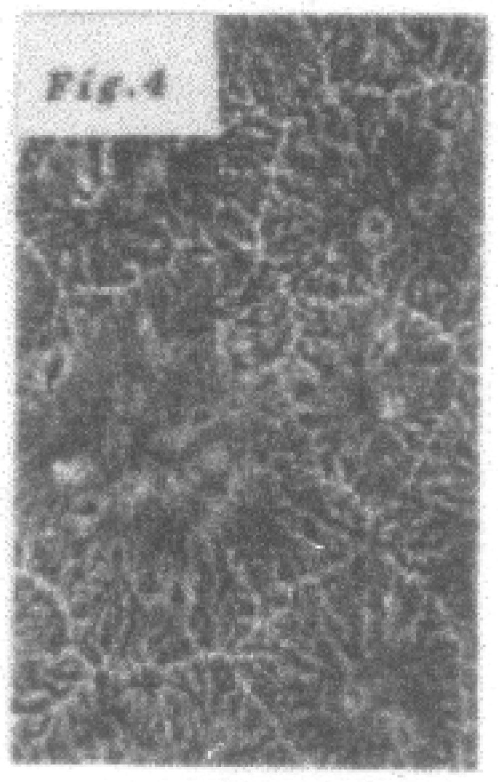
Fig.4

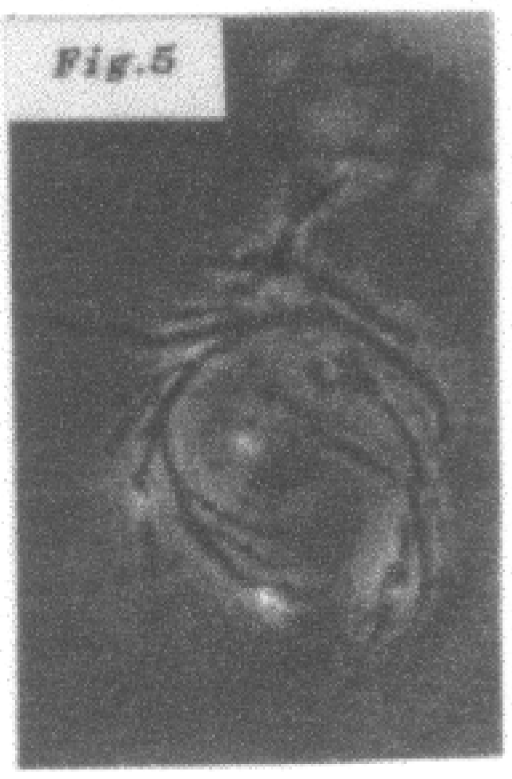
Fig.5


Fig.6

References :

1. Wilson, E.(editorial), Chem. Eng. News, **79**, Jan. 1, **2001**.
2. Mead, C.A., Collective Electrodynamics, MIT Press, **2000**.
3. Voet, D.,Voet, J.G., Biochemistry, 2d ed., Wiley, **1995**.
4. Belyakov, V.A. et al., Liquid Crystals, **1996**, **20**, no.6, 777-784.
5. Collings, P.J., Liquid Crystals, Princeton Univ. Press, **1990**.
6. Garnett, M., Remo, J.L., ECS abstracts, Phoenix, Oct. **2000**, 1152A.
7. Penn, S., Alford, N., EPSRC Final Report : GR/K70649, Nov. **1998**, www.eeeie.sbu.ac.uk/research/pem reports.