



Biofilms of *Borrelia burgdorferi* in Chronic Cutaneous Borreliosis

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3 We propose the hypothesis that *Borrelia burgdorferi* can form biofilm structures in lymphocytomas and acrodermatitis
4 *chronica atrophicans* based on Eisendle K et al¹ findings published in *Am J Clin Pathol* 2007; 127:213-222. This elegant
5 and novel immunohistochemical study used focus floating microscopy to demonstrate the presence of *Borrelia* in these
6 cutaneous lesions. The findings of this paper suggested that *Borrelia* can grow in a “medusa colony” or in a “granular
7 colony with a reddish veil” (Figures 5A and 6F in this article). Our close examination of these pictures revealed striking
8 similarity to previously published biofilm pictures² and our preliminary findings on specific Biofilm-like colony
9 formation of *Borrelia burgdorferi* when cultured in the presence of human plasma (see Figure 1).

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12 Further justification of this hypothesis will require the detailed characterization of these structures for typical biofilm
13 properties such as identifying multiple organisms in the colonies which are located in a specialized polysaccharide
14 matrix, morphological diversity of microbes in biofilm due to specialization of individual bacteria induced by the
15 recently discovered quorum sensing mechanisms and of course the occurrence of these structures in chronic infections.

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18 Bacterial biofilms are responsible for several chronic diseases (e.g. periodontitis and chronic lung infection in cystic
19 fibrosis patients) that are very difficult to treat because they show much greater resistance to antibiotics (up to 1000-fold)
20 than their free-living counterparts³. The biofilm resistance is very unique in a sense that it requires multiple mechanisms
21 such as incomplete penetration of the antibiotics into the matrix, inactivation of antibiotics by altered chemical
22 microenvironment within the biofilm (low pH, anaerobic condition etc) and an altered, highly protected phenotypic
23 “spore like” state of the resistant bacteria population⁴.

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26 If *Borrelia burgdorferi* is indeed capable forming biofilm, it will change the way how we think about Lyme disease
27 especially in patients where it seems to be persistent disease despite the long term antibiotics treatment⁵. The elucidation
28 of the molecular mechanisms responsible for the switch from free living (planktonic) growth to a biofilm phenotype and
29 the development of resistance to antibiotics should provide novel therapeutic targets for chronic Lyme disease.

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32 In summary, we suggest that chronic cutaneous Borreliosis conditions such as lymphocytomas and acrodermatitis
33 *chronica atrophicans* need further investigation to see whether these could be infections of the *Borrelia* biofilm type.

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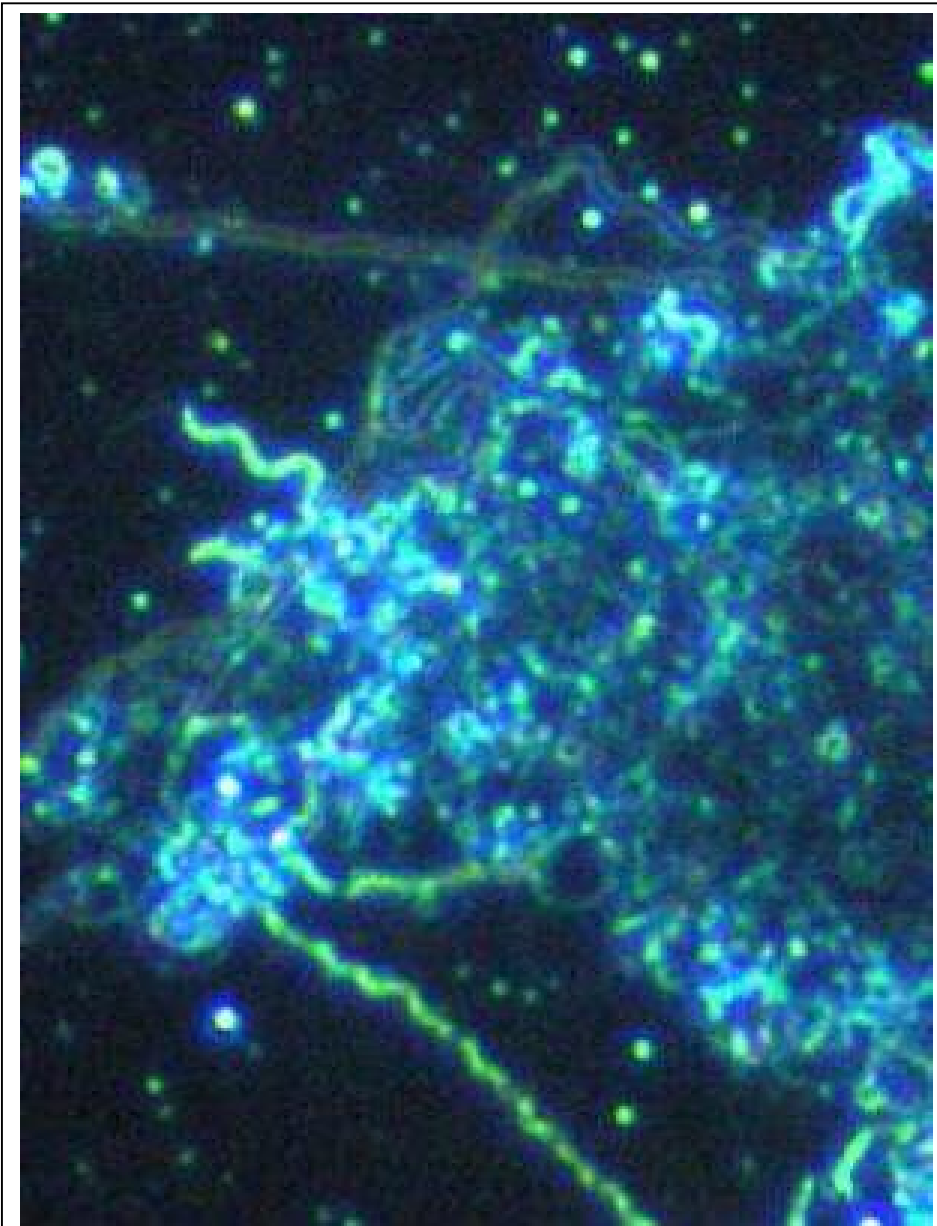
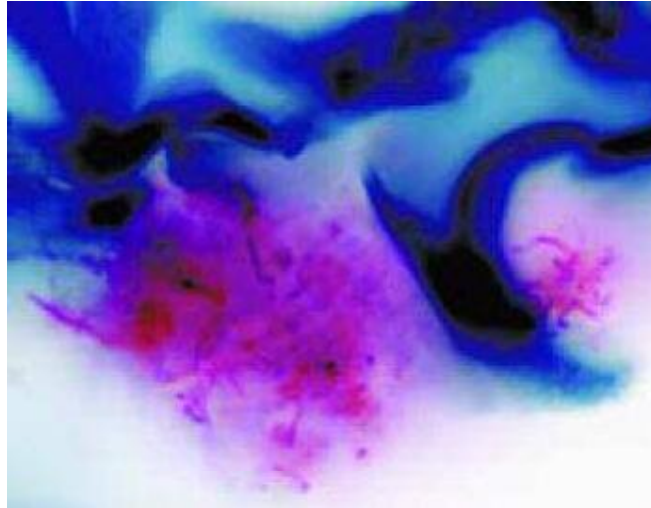


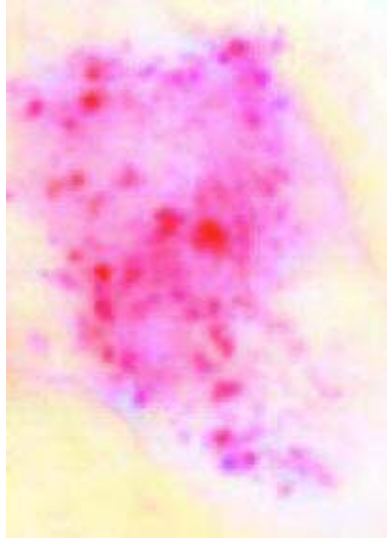
Figure 1 *Borrelia burgdorferi* in pure culture from American Type Culture Collection (35210) in BSK-M medium (Sigma Aldrich), darkfield 1000x original magnification. Conventional spiral forms merge with biofilm elements including cystic rounded forms, tubular elements and dot-like punctate granular forms in a gel matrix.

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For Comparison Eisendle Image 5
91x71mm (96 x 96 DPI)

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For Comparison Eisendle Image 6 from Acrodermatitis Chronica Atrophicans
54x75mm (96 x 96 DPI)