# The role of surface viscosity in the escape mechanism of the stenus beetle

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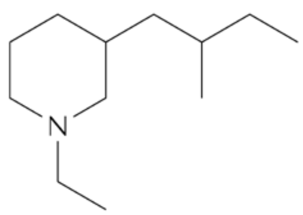
In case of falling onto water during prey, beetles of genus *stenus* excrete the spreading alkaloids stenusine and norstenusine in order to be forced back to the water's edge due to surface pressure [1]. The latter surface active molecules were synthesized in a two-step synthesis comprising an alkylation and a hydration step starting from 3-picoline and subsequently characterized with respect to their equilibrium and dynamic interfacial properties.

Measurements of equilibrium surface tension revealed only a moderate effect of surface activity on the order of a 15 mN/m surface pressure at bulk concentrations close to the solubility limit. To access the non-equilibrium properties of the respective adsorption layers, surface dilatational rheology was used for characterization. In order to study dynamics on different time scales, oscillating pendent drop (0.01 - 1Hz) and oscillating bubble (5 - 500Hz) experiments were performed. The used oscillating bubble apparatus extends the frequency range of current standard devices based on a well-known principle for measuring dynamic properties of interfacial layers. These are represented by the complex surface dilatational modulus *E*.

Next to inducing a surface pressure, these spreading alkaloids were found to render the air-water interface viscoelastic especially at fast perturbations. This high frequency viscoelasticity cannot be detected by conventional methods. This example illustrates the benefits of studies with the oscillating bubble technique and the additional information gained on non-equilibrium properties at aqueous interfaces present at biological interfaces.



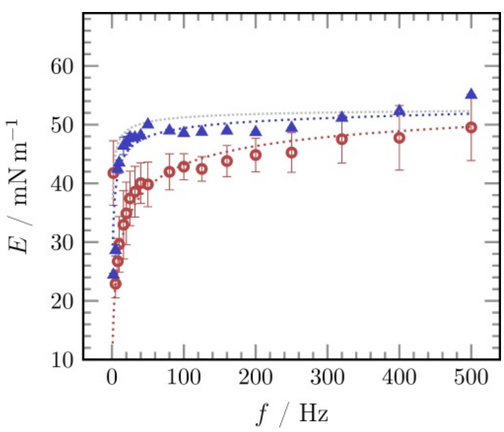




**Figure 1** Left: Molecular Structure of stenusine. Right: Adsorption of stenusine and norstenusine renders the air-water interface viscoelastic. The effect is characterized by an increasing value of the surface dilatational modulus at frequencies exceeding 100 Hz [2].

[1] H. Schildknecht, *et. al.*, *Angew. Chem.*, 1975, **87**, 421.

[2] M. J. Hofmann, A.-A. Dietz, H. Motschmann, *J. Phys. Chem. B*, 2016, *submitted*.