Amphibian Froth: Unusual linkage pattern in a blue protein found in the foam nests of tropical frogs

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(PhysOrg.com) -- An unusual blue protein called ranasmurfin and found in the foam nests of a Malaysian tree frog has aroused the interest of a team of British, Brazilian, and Malaysian researchers led by Alan Cooper at the University of Glasgow and James H. Naismith at the University of St Andrews. The colored portion of the protein contains a previously unknown type of zinc-coordinated linkage between its subunits.

Many tropical frogs protect their sensitive eggs and embryos with a foam. When mating, the female excretes a protein-rich fluid that she, together with the male, whips into a sticky foam nest that is then stuck to a structure or plant overhanging a body of water.

These tiny ecosystems contain an entire spectrum of previously unknown proteins and other macromolecules; they stabilize the foam, hold it firmly to its substrate, protect it from microbes and predators, prevent dehydration, and provide an ideal environment for the embryos.

The dark greenish-blue color of the nests of the Malaysian tree frog stems from ranasmurfin. Each monomer of this dimeric protein consists of 113 amino acids that are folded into a novel helical motif and stabilized through a series of cross-linkages, which includes an unusual lysine–tyrosine–quinone linkage. Even more unusual is the linkage between the two monomers, in which two lysine–tyrosine–quinone linkages are bridged by a nitrogen atom. This previously unknown type

of linkage forms, together with two histidine groups, the binding site for a zinc ion. With its four ligands, the metal ion is thus in a tetrahedral environment. This structure is the unit responsible for the color (chromophore) of the protein.

Currently, the biological function of ranasmurfin can only be speculated. The scientists believe that this protein, which is present in relatively large amounts in the foam, is involved in the stabilization and adhesion of the foam. Proteins with similar linkages seem to play a role in the stabilization of adhesives and cements from mussels. Blue proteins are rare in nature and the chromophore in ranasmurfin has little in common with other blue-green proteins. The blue color could play a role in camouflaging the nests or protection from the sun.

Biological foams are an interesting source of novel proteins. Unusual variations, such as the linkages in the ranasmurfin chromophore, are often posttranslational, meaning they occur after translation of the genetic code into an amino acid chain, and are thus not predictable by the analysis of DNA sequences alone.

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