Mechanics of fish skin: A computational approach for bio-inspired flexible composites

from this material is therefore of interest, but requires a fundamental understanding of the mechanics of fish skin. In particular, the design of a fish skin targeted for specific applications necessitates the elaboration of experimental and computational

2.2. A computational approach to study fish skin

Computational studies are ideally suited to assist and guide experimental efforts and determine the influence of a microstructure on the overall behavior of materials (Farsad et al., 2010; Vernerey and Farsad, 2011; Vernerey et al., 2006). A number of issues, however, arise from the fact that the length-scale at which analysis permits the determination of the periodic cell, as shown in Fig. 3b in the profile view for which five overlapping scale layers are identified: two Prime scale and three Double Primes scales. When represented in three-dimension, the periodic cell contains seven different scales that belong to five overlapping layers (Fig. 3c). In examining the three-dimensional assembly, the only portions of scales exposed are the top layer of Double Prime scales (3″) and the central scale of the top layer of the Prime scales (2'). The bottom layers of the Prime and Double Prime scales (1′ and 1″) are in essence the lower end of the scales that attach to the skin of the fish. In terms of size and geometry, a typical scale from the Morone saxatilis has a circular shape with a diameter of 0.8 cm. Size and shape, however, greatly differs from fish to fish, leading to a

constraints, yielding an overall stiffening of the skin. Finally, for higher curvatures ($\kappa \approx 1$), a phenomenon interpreted as scale locking, precludes any additional rotation; this ultimately results in a deformation regime dominated by scale bending and its associated high stiffness.

The skin response to lateral bending displays a very different behavior. Indeed, in this direction, scale rotation is obviously not activated and the only mode of deformation is bending. As a consequence, neither the local deformation fields nor the overall mechanical behavior of the skin are sensitive to differences in scale-dermis rigidities (Fig. 9). The behavior of the skin can thus be described as that of a homogeneous shell whose stiffness K_h is defined in (13).

4.3. Mechanical response of biological fish skin: case of Morone saxatilis

results from the determination and analysis of a representative volume element (or a periodic unit cells for periodic structures), which may possess feature in- and out-of-plane. We have

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