Preface

> . . . I took a half grown Chick, whose leg-bone was then two inches long, and with a sharp pointed Iron at half an inch distance I pierced two small holes through the middle of the scaly covering of the leg, and shin-bone; two months after I killed the Chick, and upon laying the bone bare, I found on it obscure remains of the two marks I had made at the same distance of half an inch: So that that part of the bone had not at all distended lengthwise, since the time that I marked it: Notwithstanding the bone was in that time grown an inch more in length, which growth was mostly at the upper end of the bone, where a wonderful provision is made for its growth at the joyning of its head to the shank, called by Anatomists Symphysis.
>
> (Stephen Hales, 1727)

Since the inception of formal investigation into the manner in which bones grow, application of the concept of *in vivo* bone marking runs through the fabric of bone research like a bright thread. From his experiment, Hales was led to a rejection of the concept of interstitial growth of osseous tissue, to an awareness of differential growth within a single bone, and to recognition of the significance of the cartilaginous epiphyseal disc. A dozen years later, Duhamel (1739, 1742), capitalizing on the accidental discovery by Belchier (1736) that madder is deposited in growing bone, systematically demonstrated that the diameter of a long bone is increased by circumferential deposition of bone tissue, layer upon layer, under the periosteum; thus he came to perceive the importance of that membrane as a proliferating agent. With Hunter's (1771, 1837) observations concerning the disposition and disappearance of madder dye from the anterior border of the mandibular ramus and the medullary surface of the long bone, remodeling resorption was revealed as a complementary mechanism, working concurrently with apposition, and equally responsible for skeletal morphogenesis. During the 18th century, then, *in vivo* techniques figured prominently in documenting those processes of bone growth which are generally accepted today.

The bone-marking concept has had a curious history in the first half of the present century in the sense that preoccupation with technological development has far outstripped interest in application. Even the *in vivo* techniques devised in the 18th century have been little exploited, at least with respect to the analysis of craniofacial growth. Bone marking, particularly with madder or the synthetic anthraquinone derivatives, has often been treated as a recondite subject having historical interest only. And it is to be noted that the contributions of even those studies which have been conducted have been incorporated only tardily into the textbook discussions of cranial morphology. One may cite for example, the inconclusive discussions by Clark ('65) and Ham ('65) pertaining to the mode of growth of the cranial vault; yet this is a subject well documented by several studies employing vital staining.

The past 30 years have witnessed the proliferation of a wide variety of techniques and materials for *in vivo* marking of growing bone. This symposium was designed to provide a comprehensive inventory of techniques available to the prospective investigator. Three broad categories of markers are here recognized: chemical, implant, and natural. The follow-

ing papers are concerned with markers which label the organic matrix as well as those which are associated with the mineral constituents of bone. Consideration is given to such factors as the biochemical mode of incorporation of the markers, the histological analysis of their distribution, and their specific utility in the interpretation of growth changes in skeletal morphology.

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