Summary

Birdsong has grown to be an indispensable model for human imitative vocal learning, and during the last decades huge progress has been made in elucidating the function of neural pathways involved in vocalization. The sound system in birds as well as mammals is not a one-way street with the brain in one end, and the peripheral biomechanics in the other. Recent studies have shown that it is a circular system of which the peripheral biomechanics is an integral part. Hence to fully understand neural coding of this complex behavior we need also to understand the biomechanics.

The study of the peripheral biomechanics of the avian sound stem has been hindered by experimental difficulties. The small size and anatomical location of the song organ, the syrinx, makes quantitative studies difficult, especially *in vivo*.

In this thesis we overcame some of the hurdles

In Chapter 3 we used a novel experimental *ex vivo* setup which allows for examination of the syringeal dynamics in high detail while subjecting the syrinx to a precisely controlled and physiological environment With this paradigms we showed for the first time that a wide range of birds use the same physical mechanism for sound production as mammals do, namely the myoelastic-aerodynamical theory. We furthermore showed that motor control of the syrinx is redundancy and multiple control settings can lead to the same fundamental frequency. These findings will allow us to use 50+ years of theory formation and experimental research on human voice production and apply it to avian vocal production.

Unfortunately *in vivo* studies of the vocal fold kinematics are experimentally difficult. In Chapter 4 we adapted and tested the noninvasive technique electroglottography (EGG) to examining the syringeal dynamics. We demonstrate that EGG can be used to predict the timing of key events in the oscillations like opening and closing of the labia, and to estimate the amount of relative tissue contact between the two sound producing labia. We hope this technique will allow future studies quantifying syringeal dynamics in songbirds *in vivo*.

Sound amplitude is a key parameter in voiced production. Remarkably it has largely been ignored in most literature regarding birdsong. To emit higher sound level you either have to increase the air pressures used to produce the sound or increase the efficiency of the sound system. One single paper has previously reported that birds achieve an astonishing high level of efficiency compared to humans. We revisited this claim and revalidated the statement.

Together with the Complex Flow Lab at the Engineering Department at the University of Maine we developed a high fidelity continuum model for the avian vocalization. We used our unique experimental approach to test both kinematic as well as acoustical predictions of the model. We find very good match between observed- and predicted values. Our model is based upon individual µCT scans and real life tissue properties. This enables future studies to simulate neurological input by changes in geometry and hence shed light on the motor mapping onto the syrinx.