preface

The South African clawed frog, *Xenopus laevis*, has a long history in laboratory research and classroom teaching. In 1802, French naturalist and zoologist Francois Marie Daudin wrote the first description of what he called *Bufo laevis*, or "Crapaud lisse" (smooth toad). Over the following decades, taxonomists and anatomists continued to study the unusual species, which was neither a typical frog nor a typical toad. In 1890, J.M. Leslie gave the earliest account of the breeding habitats of the species that had become known as *Xenopus laevis*. That name stuck and over the next 30 years, *Xenopus* rose to dominance in research, imported from Africa to laboratories in Europe and North America. Between 1930 and 1960, *Xenopus* became the leading animal model in developmental biology, endocrinology and biochemistry. In the 1940s, the species gained widespread use in hospital laboratories as a means of detecting human pregnancy. (Injection of urine from a woman results in *Xenopus* egg-laying if the hormone associated with human pregnancy, human chorionic gonadotrophin, is present.) In the early 1980s, the Frog Embryo Teratogenesis Assay *Xenopus* (FETAX) was developed and is now the standard laboratory system that tests the toxicity of environmental pollutants and other substances by evaluating their effects on embryonic mortality, growth rate, and malformation. Today, *Xenopus* is a major non-mammalian laboratory animal model in vertebrate embryology, toxicology, cellular biology, physiology, biochemistry, and biomedical research.

Xenopus are especially suitable for the laboratory because they are hardy, long-lived, and readily adaptable, and because gametogenesis can be hormonally induced to occur year round. Thus the oocytes, eggs, and embryos harvested from *Xenopus* can provide scientists with a continuous source of material for research. Eggs and oocytes (fully-grown egg precursor cells) collected from *Xenopus* are plentiful and quite large (~1.0 to 1.2 mm) and are used to prepare cell-free cytoplasmic extracts to study a variety of biochemical and cellular processes—the mitotic cell cycle, molecular signaling pathways, nuclear assembly, nuclear transport, and the transcription, translation, and expression of mRNAs—and for the analysis of ion channels via electrophysiological recording and expression cloning. Eggs and embryos are also readily suitable for microinjection and microsurgery and are used to study cell fate, axis formation, migration, and morphogenesis of the developing vertebrate.

X. tropicalis, a smaller cousin of *X. laevis*, shares all of the utility of *X. laevis* as an animal model but offers the additional advantage of being a diploid species that readily lends itself to genomic sequencing. *X. laevis* is allotetraploid: that is, many genes are represented by extra copies that may or may not be functional (this feature makes creating *X. laevis* mutants and analyzing gene regulation difficult). *X. tropicalis* has the additional advantages of having a comparatively shorter generation time (in 3 to 4 months of morphogenesis they will reach sexual maturity, versus 1 to 2 years for *X. laevis*) and a smaller genome (10 pairs of chromosomes compared with 18 for *X. laevis*). As transgenic *X. tropicalis* become more widely used and available, the use of this species in laboratory research will expand.

Because reporting methods vary from country to country, the exact number of *Xenopus* used in research worldwide is unavailable. However, between 1998 and 2009, the number of published studies making use of *Xenopus* as cited on *PubMed* increased five fold. Just two decades ago, research animal facilities were unlikely to house more than a few hundred frogs. Today, maintaining very large populations of *Xenopus* (several hundred to several thousand frogs) in a laboratory environment is increasingly common.

Despite the popularity of *Xenopus*, there is a lack of standardization and a paucity of hypothesis-driven research regarding their optimal care, husbandry, and housing. Much of what we currently know about caring for large numbers of this species in captivity has been learned through trial and error, time-honored laboratory techniques, and contributions from hobbyists, wildlife specialists, and zoos. Most laboratory animal veterinarians have limited formal training or experience with *Xenopus* and must often learn the basics of aquaculture, amphibian medicine, and experimental methodology while on the job.

This handbook is written to assist research scientists, technicians, animal caretakers, and particularly the laboratory animal veterinarians charged with the care of laboratory *Xenopus*. The book is organized into six chapters: Important Biological Features (Chapter 1), Husbandry (Chapter 2), Management (Chapter 3), Veterinary Care (Chapter 4), Experimental Methodology (Chapter 5), and Resources (Chapter 6). This handbook is not intended to be an exhaustive review of *Xenopus* biology or of research methodology, but rather a quick reference for concise and basic information. Individuals performing procedures described in this handbook should receive proper training, keeping in mind the humane use and the welfare of a species that was once considered of a "lower" order. The products and protocols cited throughout this book are not an endorsement over those not listed, but rather are intended as starting reference points.

It is my sincere hope that those who manage laboratory *Xenopus* colonies ranging in size from just a few frogs to several thousand will find this manual useful.

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