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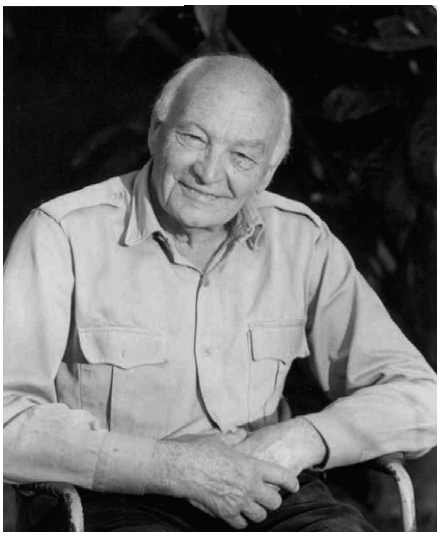
E.S. Grossman*

On 10 September 2005, we celebrate the centenary of the birth of Boris Ivan Balinsky, one of the best-known and most respected embryologists of the twentieth century. Through his remarkable and painstaking research, he laid the foundation of developmental biology as we know it today. Balinsky was a man whose research was shaped by his time, and for the first half of his working life this was dictated largely by the turbulence of the Russian Revolution and later by the instability of the Second World War. Soviet life depended on the whims of the man in power at any given time: thus, the course of Balinsky's research was directed according to the situation in which he found himself and the facilities available to him. It is due to his insight, single-mindedness, ability to adapt, hands-on approach and meticulous technique that he managed to achieve the noteworthy research and groundbreaking findings in the years prior to, and after, his move to the West.

BALINSKY WAS BORN IN KIEV, UKRAINE, THE elder of two sons of Ivan Balinsky, a history teacher, and Elizabeth Radzimovsky, a biology teacher. His interest in zoology began during the summer holidays he spent in the village of Severinovka, 80 km southwest of Kiev, where his maternal grandfather, a Russian Orthodox priest, lived. The country life with beekeeping, farming and harvesting was instrumental in directing his passion for the outdoors, and a book, by Akasov on collecting butterflies which he received in 1916, marked the beginning of his interest in the natural sciences. It was fortunate that Boris's curiosity about nature was encouraged prior to his formal schooling, which started in 1917, the year of the Russian Revolution, as he found natural history 'a great disappointment' at his first school.

In 1923, he started his zoology studies under the famous evolutionary biologist, Professor I.I. Schmalhausen, at the University of St Vladimir (subsequently the University of Kiev). All students were obliged to present a seminar as part of the course. At the suggestion of Schmalhausen, Balinsky based his presentation on a recent paper on the specificity of germinal layers in *Triton* by Otto Mangold and this was to launch him on his career as an embryologist. A further consequence of the seminars was that Balinsky met his future wife, Katia Syngayevskaya, also a student, at these meetings. Balinsky's undergraduate experiments on the transplantation of the ear vesicle of amphibian (newt) embryos soon earned him a reputation as a promising scientist.

The groundbreaking discovery of this work, the induction of supernumary limbs in newt embryos, was published as his first scientific paper, in 1925. It is rare indeed in the scientific world that a researcher's first studies as an undergraduate establish a lifelong international reputation. He completed his course in 1926, but this was not concluded with the awarding of a degree: this was considered bourgeois at the time. Balinsky rose quickly to the status of professor of embryology at the university and deputy director of the Zoological Institute of the Ukrainian Academy of Sciences by 1933. In addition to his embryological studies, he examined development in invertebrates such as sea urchins and ascidians. He revived his interest in entomology, focusing on stoneflies, which he ultimately collected and described in diverse locations such as the Caucasus, southern Germany, Scotland and southern Africa. Of more practical use, he received German lessons from an Austrian Serb, a language which was to stand him in good stead in the future.



Boris Balinsky as he was in 1975.

The Soviet government subsequently reversed its attitude towards academic qualifications and re-introduced scientific degrees. This enabled Balinsky to submit a monograph entitled 'Induction of the Limbs in Amphibia', for which he obtained the doctorate of biological sciences from the Ukrainian Academy of Sciences in 1935. At that time the situation in the academy was very favourable, in part due to its president, academician Bogomoletz, who was held in high esteem by the Communist authorities. It was under his directorship that the academy acquired control over the Marine Biological Station at Karadag in the Crimea, a move that was to play a decisive role in Balinsky's life.

Balinsky then moved on to study the development of the endoderm, which gives rise to the alimentary canal. By systematic marking and transplant experiments in amphibians, he was able to trace the origins of different organs arising from this inner germinal layer. This work turned out to be innovative, interesting and unexpected and led to several publications. This productive period came to an end on 22 October 1937, when his wife Katia was arrested and sentenced to 10 years' confinement in a work rehabilitation camp for 'engaging in counter-revolutionary propaganda', leaving Boris to care for their three-year-old son Ivan (Vania). Consequently, Balinsky was relieved of his lecturing duties, lost his posts of professor of embryology at the university and deputy director of the institute, although he was able to continue his work at the latter. When Katia was released 18 months later, with all charges withdrawn, his working life was restored to much the state that existed before her arrest, but nevertheless neither his professorship nor his post of deputy director was ever reinstated.

Between Katia's release and the war with Germany in 1941, Balinsky continued with his work on the developing alimentary canal in amphibians, concentrating on the interaction of events involved in the formation of the mouth. He also expanded his research to fish embryos, in particular the development of fins, using the goldfish as a model. In this way he hoped to shed some light on the transition from fins to legs in the course of evolution. Boris Balinsky's standing in the scientific world also gradually improved after the setback it had received from Katia's arrest. He was asked to edit two monographs, a long chapter on amphibian embryology and he started a textbook on comparative

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embryology. This last had to be aborted by the beginning of the war with Germany. In December 1940, he received a formal distinction from the Academy of Sciences of the USSR in Moscow — the Kawalewsky Prize, for his work on the determination of the endoderm in amphibian embryos. In 1941 he was appointed professor of zoology at the medical school in Kiev.

The Germans attacked the Soviet Union on 22 June 1941. At the time the Balinsky family was at the Karadag Marine Biological Station in the Crimea, where Boris wished to combine a family holiday with some scientific work on marine animals and their embryos. With no immediate possibility of returning to Kiev, they managed to get to Kharkov, where he was able to regain contact with the Kiev Medical School, which had been evacuated to the town. He also found employment with the railways as chief of the rat-catching division, a job requirement for this post being biological training! It was at this time that Balinsky made the 'most momentous decision' of his life. By avoiding evacuation to Siberia with the medical school and remaining in Kharkov, he opened the possibility of eventually moving to the West. Once he was able to return to Kiev, he was appointed to the staff of the Fisheries Institute, one of several research centres allowed under the German occupation. Boris's work on goldfish embryos was instrumental in his appointment and he was able to expand these studies to include the developmental stages of commercial fish, as well as identifying the larvae of the many species of fish in the waters adjoining the station. For this latter project he used the distribution of pigment cells inside the transparent body as a useful means of distinction. This work was published some six years later in Scotland.

During the autumn and winter of 1942/3, Boris spent time writing up the results of experiments on the determination of parts of the endoderm in newts and salamanders. Using 5-watt lamps in his flat, he was able to set up an apparatus to make photomicrographs of sectioned material to illustrate the work which was subsequently published in *Roux' Archiv* after the war. He also prepared a manuscript on stoneflies that was published in England. It was during this time that Katia fell ill and died on 31 March 1943 after a period of poor health. By mid-September of that year it was evident that the German retreat from Kiev was only a matter of time and the institutes under German control, together with their staff, were to be evacuated to Posen in the western part of Poland. Before the end of the month, Boris, his mother Elizabeth and Vania left for Poland, accompanied by three packing cases containing their personal belongings and all of Boris's scientific records and research equipment.

In Posen, Balinsky was able to section most of the embedded embryos prepared during 1941. In the spring of 1944 he was also able to obtain additional fresh material from fish with commercial value, such as the carp and roach, and was able to complete the developmental stages of these fish with every stage accurately drawn in black ink and with shading — a painstaking task. He also designed what he came to regard as his 'personal coat of arms', a five-legged newt, in recognition of his first success in experimental embryology. This he ultimately used as a frontispiece in his book on embryology. In December 1944, the institute was evacuated yet again, this time to Marburg. As it turned out, the Fisheries Institute was never re-assembled in Marburg and Balinsky lost virtually all the results of five years of work including his drawings of fish stages. He found respite in the Zoology Department at the University of Tübingen. The German scientific community recognized his lack of income and gave him laboratory space for research whilst paying him a stipend from the *Notgemeinschaft der Deutschen Wissenschaft.* This was not to last. By December 1945 he moved to the American Occupation Zone in Heidelberg to avoid enforced repatriation. This was a step which took him closer to his goal of working in the West.

He then served as professor of histology and embryology and head of department at the Displaced Persons University, organized in Munich under the auspices of the United Nations Repatriation and Rehabilitation Administration for so long as it existed (1945–47). A textbook on histology for students taking the course (*Vorlesungen über Histologie*) serves as a tangible reminder of this time, for which Boris wrote and prepared 85 drawings. In Munich, he also met Elizabeth (Betty) Stengel, who was to become his second wife, on 15 March 1947.

The post-war situation in Germany was desperate: and although Balinsky wished to emigrate and settle in the United States, their American intelligence screening was unfavourable. Argentina was also a possibility but that would have meant working as a farmer, something that did not appeal. Boris sent his CV around the English-speaking world and had two approaches: a tentative one from Professor van der Horst, head of the Department of Zoology at the University of the Witwatersrand in Johannesburg, the other a firm offer from Professor Waddington at the Institute of Animal Genetics of the Agricultural Research Council in Edinburgh, Scotland. Unfortunately, the condition was that he come to Scotland alone, without his family. Having no real choice, he went to Scotland in October 1947, with his mother, Betty and Vania joining him six months later. Boris's initial work was to investigate the factors controlling the number and location of milk glands in mice. This was subsequently expanded to a study of the morpho-physiological mechanism of the early stages of development of the mammary glands in rabbits and cattle. During this time he conceived the layout for a book on embryology, which he followed some years later as *An Introduction to Embryology.* In 1949 he received an offer of a lectureship at the University of the Witwatersrand (Wits) which he accepted, arriving in Johannesburg in September 1949 with his family, including his newly born daughter, Helen.

Balinsky immediately started a new series of investigations on amphibians using the numerous and varied species of South African frogs. By hetero-transplants between embryos he gained information on factors determining the size and differentiation of organ rudiments between species. He also resumed his work on the embryology of marine invertebrates during visits to the Biological Marine Station on Inhaca Island, off the Mozambique coast. Within five years (1955), he was promoted to fill the chair of zoology and headship of the department at Wits. In 1956 Balinsky went to Yale University for his sabbatical leave, where he was introduced to the two outstanding pioneers of biological electron microscopy, Drs G.E. Palade and K.R. Porter of the Rockefeller Institute in New York. With growing excitement, he realized that the techniques of electron microscopy would help him solve a number of problems in his work on limb induction. On his return to Johannesburg, he was delighted to learn that the university had in the mean time acquired a Siemens Elmiskop 1. This enabled him to use electron microscopy to advance his embryological studies, which he expanded to include sea urchins and insects. In doing so he was the first person to practise biological electron microscopy in this country.

One of the great achievements of Boris Balinsky was the manner in which he pioneered the application of the electron microscope to the study of the ultrastructure of early development, how he foresaw the relevance of molecular biology to the understanding of development and the way in which he achieved a synthesis of these two approaches. This interest led him to become a founder member of the Electron Microscope Society of Southern Africa, of which he served as

president between 1962 and 1973. The Boris Balinsky Lecture is given at the society's annual meetings to honour his contribution. In addition, he was an active member of the South African Association for the Advancement of Science, the Entomological Society of Southern Africa and the International Institute of Embryology.

Boris Balinsky filled the chair of zoology and headship of the department until his retirement at the end of 1973. He was dean of the Faculty of Science from 1965 to 1967 and was awarded the degree of D.Sc. *honoris causae* by the University of the Witwatersrand in 1978. He was a dedicated and productive researcher until he died, publishing 133 research papers and several books, mainly in the fields of experimental embryology and entomology. A paper on the electron microscope investigation of frog development was celebrated as a 'citation classic' by the journal *Current Contents* in 1984.

While Balinsky's experimental work on the induction of supernumary limbs brought the greatest international recognition and acclaim, his textbook entitled *Introduction to Embryology,* which was first published in 1960, secured his international reputation. The book was based on courses given to students at the University of the Witwatersrand. Such was its impact that it has been published in five English editions, two Japanese, two Italian and one in Spanish. It was certainly the most widely used embryology textbook in the world and has influenced the education of countless numbers of students.

Balinsky was a man of many talents, many interests and many achievements. His abiding interest in insects, which started in 1916, led to ongoing collecting of stoneflies, dragonflies, butterflies and moths. This resulted in his identifying, describing and naming several new species of the families Odonata and Plectoptera. On his retirement, he was appointed professor emeritus and honorary research professorial fellow by Wits University in recognition of his many achievements. He worked on the classification of moths for the Transvaal Museum and, in 1984, he was awarded the status of Associate Member of the museum. Even in the last years of his life he engaged in yet another new field of study, the genetics of the butterfly *Acraea horta.*

Among his other interests were music, piano-playing, oil-painting, gardening and astronomy. He is one of the few people who have observed Halley's comet twice. His deep love of animals and nature also led to extensive travels in the wilderness areas of southern Africa, with family, friends and students from Wits.

Scientists who have achieved international recognition across a range of disciplines are rare indeed. Boris Ivan Balinsky was such a person, through his pioneering contributions in the fields of embryology, entomology, genetics, and herpetology.

This article is based largely on Balinsky's own account of events, courtesy of the Boris I. Balinsky Memoir, Record Series 15/35/57, in the University of Illinois at Urbana-Champaign Archives. It was prepared under the aegis of the Microscopy Society of Southern Africa.

List of publications

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