THE EVOLUTION OF THE ART AND SCIENCE OF THERIOGENOLOGY*

Stephen J. Roberts, D.V.M., M.S.**
(The Second David E. Bartlett Honorary Address)

It was indeed an honor to be asked to present the second annual David E. Bartlett Honorary Address to this joint meeting of the Society for Theriogenology and the American College of Theriogenologists. I wish to pay tribute to the significant role my long-time friend and colleague David E. Bartlett has played in establishing both the Society and College and call particular attention to his first Address detailing the formation, goals, problems and final success he and others had in establishing within the short span of the last 13 years the present vigorous and highly successful Society and College.

In reviewing the publications and authors in this field over the past eighty-five years to define and relate the evolution, science, and history of theriogenology, I realized I was fortunately and appreciatively exposed to most of this evolution by personal contacts, associations and friendships with many of the outstanding professors, veterinarians, biological scientists, medical doctors and others who developed and produced the knowledge, science and subspecialties that undergird our present very broad and fascinating field. Ralph Waldo Emerson, one of the sages of New England, wrote, "There is properly no history, only biography." The biographies of the outstanding men and women in our field as proven by their work, is to my mind and experience, the history or the evolution of the science of theriogenology.

During the past 30 to 40 years the field of theriogenology has expanded enormously (see Figure 1). A parallel and synchronous expansion has also occurred in the other applied science or clinical fields[82] (Figure 2). In the late 1890's and early 1900's the veterinary field of animal reproduction and obstetrics was relatively amorphous and was incorporated under the disciplines of surgery, medicine and animal husbandry or zootechnics and dealt largely with horses and to a lesser degree with cattle. Much of the early advances and literature on reproduction and obstetrics was developed by the older European veterinary colleges and institutes in Germany, France, Denmark, Switzerland, Austria and England. Thus many "obstetrical" books in the veterinary libraries in that period required a good reading knowledge of German and French. Some of these early veterinary authors included: Benesch, Fleming, Craig, Gotze, Richter, Albrechtsen, Franck, Harms, Stoss, Gurlt, Zietzschmann, Tillman, Tavernier and Bang.[11-18]

Franz Benesch of Vienna, a close friend of Drs. D. H. Udall and M. G. Fincher of Cornell, developed the Benesch Universal fetatome that was widely used in the U.S. from 1910 through 1960. He first described the technique of epidural anesthesia in

* Presented at the Annual Fall Conference of the Society for Theriogenology, Sept. 11, 1985, in Sacramento. Calif.

** Prof. Emeritus, Cornell Univ., Box 124, Prosper Rd., Woodstock, VT 05091.

FIGURE 1

THE EVOLUTION AND SCOPE OF THERIOGENOLOGY[1]

Time[2]	Disciplines	Specialties: Species
1870		
	Anatomy	
	Pathology	Horses
	General Physiology	
	Bacteriology	
	Surgery	
	Obstetrics	Cattle
	Clinical Diagnosis	Sheep
	"Materia medica"	Swine
1935	Endocrinology	
	Embryology	Dogs
	Genetics	Poultry
	Pharmacology	
	Animal Management	Cats
	Animal Reproduction	
	Nutrition	
	Artificial Insemination	
	Immunology	Laboratory Animals
	Epidemiology	Goats
	Clinical Pathology	
	Virology	
1960	Radiology	
	Teratology	
	Toxicology	Fish, (Amphibians)
	Cytogenetics	
	Physiology of the Fetus, Placenta and Gestation	
	Ethology	Wild Animals, Birds
	Embryo Transfer, Storage and Manipulation	
	Ultrasonography, Endoscopy	
1985	Biotechnology	

[1] The broadest field in veterinary medicine. The term "theriogenology" was introduced by Bartlett and others in 1970.

[2] These time intervals are only approximate since a few "developments" and "discoveries" predated the recognized establishment of a well-developed, organized discipline or species specialty.

1926.[10] He wrote the textbook "Veterinary Obstetrics" in English in 1938 which was the basis of further editions by J. G. Wright (1951) and G. H. Arthur (1964).[9] Another old and accepted text was "Veterinary Obstetrics" written by George Fleming of England that was revised in 1918 by J. F. Craig. Many of the above professors of surgery and obstetrics developed a wide variety of obstetrical instruments for the relief of dystocia by "embyrotomy" operations including special instruments such as: finger knives, Colin's scalpel, wire saws, Persson's chain saw, embryotomes, chisels, cutting hooks and other modifications of the fetotome such as Thygesen's. Later in the 50's the correct term "fetotomy" was applied to these operations on the fetus.

In 1897, Bernard Bang of Denmark described a bacillus that caused abortion in cattle and for many years this bacillus was considered the only, or the principal, cause of bovine abortion.[17] I was not personally acquainted with any of these outstanding European veterinarians but my former professors and colleagues at Cornell did know them and visited their clinics and related their experiences and contacts with them to me. Although many cultural, serologic and epidemiologic studies on brucellosis were reported world wide from 1900 to 1940, the disease was not brought under control in the U.S. until after the 1950's with the introduction and widespread use of Strain 19 brucella vaccine and with the development of the whey and BRT tests on milk as dairy herd screening devices by Hugh Cameron of California an early coworker with H. L. Gilman and R. R. Birch of Cornell, M. H. Roepke of Minnesota, David T. Berman of Wisconsin, one of my early students, and C. A. (Chet) Manthei. In later years, Dr. Manthei of the USDA and then Paul Nicoletti of the USDA and the University of Florida did much to further define the disease and improve diagnostic methods and the Strain 19 vaccine.[15] Drs. C. A. Manthei, A. B. Hoerlein and others during this period also provided basic studies necessary to control swine brucellosis.

Probably the most influential veterinarian in establishing the basis of modern theriogenology in the U.S. was Dr. Walter L. Williams (1856-1945).[19,20] He was born on a farm near Decatur, Illinois, and attended the Illinois Industrial University (later the University of Illinois) and the Montreal Veterinary College from which he graduated in 1879. Dr. Williams enjoyed relating the lectures he attended at the latter College given by the noted physician and professor of medicine, Sir William Osler. He spent 12 years in veterinary practice in Bloomington, Ill. during which he served as Asst. State Veterinarian, and worked with Drs. James Law and Leonard Pearson investigating an outbreak of dourine in Percheron horses imported from France. Because of ill-health he retired from practice and taught for one year at Purdue University and three years at the Montana Agricultural College. He was appointed professor of surgery and obstetrics on the Cornell faculty in 1896 and served with distinction until retiring in 1921. He remained in Ithaca working at the Veterinary College as an emeritus professor until his death in 1945. During this period at Cornell he wrote two books; "Veterinary Obstetrics"[13] published in 1909 that he revised in 1917, 1931, 1940 and 1943 and "Diseases of the Genital Organs of Domestic Animals"[14] published in 1921 and revised in 1939 and 1943. These were translated and published in Spanish and Italian editions. These books established the subject areas of veterinary obstetrics and genital diseases that became the basis of courses presented in the curricula of all veterinary colleges in the U.S. and many throughout the world.

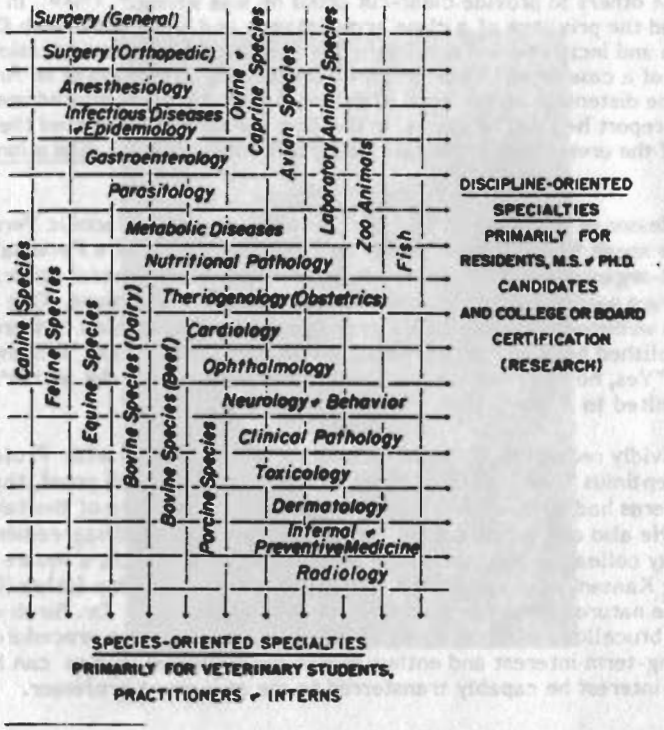


FIGURE 2 The Emerging Fabric of the Modern Veterinary College Clinical Department [82]

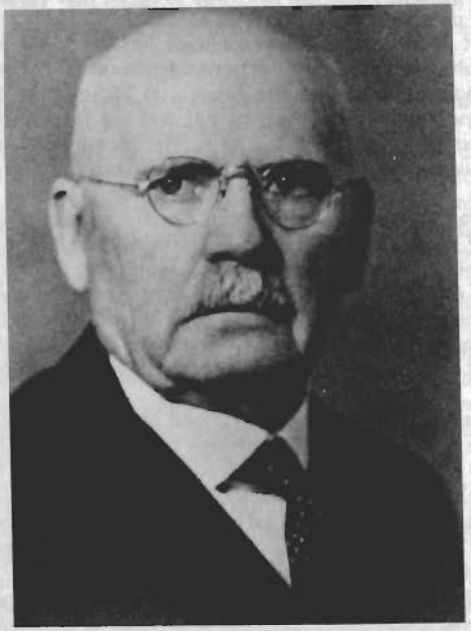
(Courtesy JAVMA)

Dr. Williams, often called "Billy" Williams by his close associates, was a short, bald, heavy-set, pugnacious, hard-working, opinionated and outspoken individual. As stated by Dean W. A. Hagan of Cornell in an eulogy, "His intolerance for sham and even for honest opinions differing from his own made many enemies but he had many strong and admiring friends as well. For many years he was a "storm center" in veterinary meetings and in the veterinary press. Being human, he was not always right but he did stimulate others to provide clear-cut proof he was wrong." [19,20] In the late 30's and 40's I had the privilege of a close acquaintance and association with Dr. Williams and his keen and incisive mind and forthright statements. On one occasion I showed him a draft of a case report I had prepared concerning a dystocia in an Angus cow caused by the distention of the fetal abdomen due to a greatly dilated ureter. After reading the report he said, "Roberts, in the first paragraph you stated the cause to be a dilation of the ureter and in the last paragraph you called it a dilatation. Now which is it?"

In 1938 Professor of Medicine D. H. Udall, a spare, scholarly, laconic Vermonter, had Dr. Williams speak to us senior students on "The Importance of a Personal Library". After a well-organized lecture, in which Dr. Williams cited several aphorisms made nearly 60 years earlier by Sir William Osler, he asked for questions. One emboldened student who withstood Dr. Williams' fierce stare asked his opinion concerning a recently published book on horse breeding by an Army major. Dr. Williams harumphed and replied "Yes, he had read the book and it was unfortunate the author's experience had been limited to Army geldings."

I can still vividly recall Dr. Williams recounting his arguments with Professor of Anatomy, Septimus Sisson, of Ohio State to the effect and with proof, that the ruminant uterus had no so-called "body" as such only a juncture of the two horns at the cervix.[14] He also carried on a long, but eventually a losing, disagreement with a noted faculty colleague and brucellosis expert, Dr. R. R. Birch, a square jawed, solid, slow talking Kansan, who was a good friend and classmate of my father (Class of 1912), on the nature of the resistance to abortion in cattle.[20] Dr. Birch was noted for his work on brucellosis control, especially by test and slaughter procedures. Dr. Williams long-term interest and enthusiasm in teratological studies can be seen in his texts. This interest he capably transferred to me as a young professor.

The son of Dr. W. L. Williams, W. W. Williams, born in 1892, followed his father's illustrious, scholarly and energetic example. He graduated from Cornell after receiving his DVM degree in 1915. Dr. W. W. Williams was a close friend and associate of a number of young professors on the Cornell faculty including Dr. M. G. Fincher my professor of obstetrics and later my department head for over 20 years. In 1919 Dr. Williams investigated a dairy herd with a severe infertility problem. About 20 percent of the herd developed pyometra within 3 months after service to one of 5 herd sires. Although examination did not reveal trichomoniasis, the probable cause of the pyometra, examination of the bull's spermatozoa did reveal that 2 bulls were infertile. This latter finding started Dr. Williams on his lifetime studies on animal and human infertility. In the mid-1920's Dr. W. W. Williams and Alfred Savage of the Manitoba Agricultural College undertook a study in bull fertility evaluation that was the first



Dr. W. L. Williams (1856-1945)

Copy of portrait, courtesy of Cornell Unive

large study of male infertility in animals or man.[22-24] Dr. Williams developed a staining technique for spermatozoa that is still commonly employed and together with Dr. Savage reported on the physical and semen examinations of 276 bulls of which 11.3% had definite seminal deficiencies. Similar studies in Colorado in 1963 resulted in similar findings.[2,5,7]

In 1935 Dr. W. W. Williams received his M.D. degree and established a human infertility clinic and practice in Springfield, Mass. in 1936. As Erik Blom of Denmark stated "This scientist never forgot his veterinary past."[25] He published over 130 papers and monographs including two editions of a book on human sterility in 1953 and 1964. He was a founding member of the American Society for the Study of Sterility, a counterpart of the Society for Theriogenology, and the International Fertility Association with their corresponding journals. He encouraged many veterinarians such as M. G. Fincher, Erik Blom, myself and others to attend and present papers to the above organizations. We were most welcome at these meetings and it afforded us a unique opportunity to meet, hear and associate with outstanding gynecologists, medical doctors, and basic reproductive scientists such as John McLeod, Abner Weisman, Fred Simmons, John Haman, M. C. Chang, Carl Hartman, John Rock and others in the rapidly expanding field of human contraception and infertility. Drs. Chang and Rock pioneered the development of the first human birth control pill in the 50's. We should be pleased and honored that Dr. W. W. Williams has recently become an honorary diplomate of the American College of Theriogenologists.

Other noted veterinarians that further advanced obstetrical and applied animal reproductive science in the late 1920's through the 1950's were Nils Lagerlof of Sweden, M. A. (Mac) Emmerson of Pennsylvania, D. H. (Denny) Udall, M. G. (Mike) Fincher, H. H. (Hugh) Dukes, Peter Olafson and H. L. (Herb) Gilman of Cornell, W. F. Guard , a surgeon at Ohio State University, W. L. Boyd of Minnesota, E. R. (Beanie) Frank of Kansas, W. W. Dimock and E. A. Caslick, a practitioner, in Kentucky and Cassius Way and Earle Hopper practitioners in the Northeast.[13-17,28,29] Most of these early outstanding veterinarians were farm-raised with a practical background with large animals which was generally characteristic of most veterinary students of this era.

Nils Lagerlof made a number of detailed studies on bovine seminal pathology associated with degeneration of the seminiferous tubules produced by insulation of the scrotum.[28,29] He developed an outstanding department in the Swedish Veterinary College at Uppsala with colleagues including Ingmar Settergren, A. Bane and D. Gustavsson. Dr. Lagerlof published and travelled widely in Europe and the U.S. and held many international courses and seminars on infertility in cattle. The author remembers distinctly one relaxed occasion in Ithaca when this scholarly veterinarian explained in detail and by example what is meant by the North European expression "Skol" when drinking and exchanging greetings with friends.[42]

In 1932 Dr. "Mac" Emmerson first definitely diagnosed trichomoniasis as a cause for infertility in cattle in the U.S. shortly after it had been discovered by Riedmuller and Abelein and others in Germany and Italy.[13,28] Within a few years this disease was reported by S. H. McNutt and others in Iowa and H. S. Cameron, M. G. Fincher and H.

L. Gilman in New York.[13,15] Later the gregarious Dr. Emmerson became a long time faculty member and sports enthusiast at Iowa State University. In the late 40's our own Dave Bartlett completed his Ph.D. degree and published extensively on bovine trichomoniasis as found in herds in the Maryland-Pennsylvania area. In later years in the AI industry Dr. Bartlett's interest in bovine venereal and other infectious diseases resulted in a number of scholarly well-researched papers on diseases capable of being transmitted by bovine semen. Because of the wide-spread adoption of artificial insemination in dairy herds in the U.S., trichomoniasis is now only seen commonly in beef herds using natural service.

Dr. D. H. Udall and his younger colleague Dr. M. G. Fincher, established an excellent ambulatory or field clinic at Cornell and published many case reports in the "Cornell Veterinarian" on obstetrical, reproductive and disease problems in dairy cattle. "Mike" Fincher, noted for his neatness, energy and direct approach was also a fast but skillful driver of an ambulatory car. He described the technique of "slipping" placental membranes in the diagnosis of pregnancy in cattle and the technique for the very early detection of free-martins.[15] Dr. Fincher from his own extensive experience over many years in dairy herds pioneered and proved the economic value of the conservative approach to the treatment of the common condition of retained placenta and metritis rather than the traumatic, forceful, removal formerly practiced. These veterinarians were ably assisted as was the author by scholarly, practical colleagues, Walter Gibbons, H. H. Dukes in physiology, Peter Olafson in pathology and H. L. Gilman in bacteriology and serology. Drs. W. F. Guard, a highly respected surgeon at Ohio State, and W. L. Boyd an excellent clinician at Minnesota also published widely on obstetrical and reproductive studies during this period.

From 1938 to 1942 the author had the early stimulating experience and pleasure of sharing an office and working closely with the quiet, restrained, scholarly, skillful surgeon Dr. E. R. (Beanie) Frank of Kansas State University. Although earlier occasional descriptions of bovine and porcine caesarean operations had been reported, we published several papers that may have established this operation as a practical procedure for the relief of severe feto-pelvic disproportion in beef heifers and gilts in the midwest.[30,31] Dr. Frank had a highly developed but quiet sense of humor. On one occasion when a man came into the Clinic Office with a bobcat in a box and asked for the veterinarian in charge of the Manhattan, Kansas zoo with the question, "Where is the wild animal vet?" Dr. Frank replied, "and where did you put the comma?" In 1940 no veterinary hormonal preparations were available other than adrenaline and posterior pituitary extract even though basic science studies had reported on the presence of hormones in the follicular fluid and corpora lutea. I can recall on several occasions securing 10 pounds of frozen bovine ovaries from a packing plant in Kansas City. Dr. Frank and I thawed them and in a near sterile manner ground up and pressed out the fluid from these ovaries which we used empirically for injecting into infertile and anestrous cattle. As might be surmized our experiments were failures. However, we did incidentally discover that this ovarian fluid would suppress milk production and prevent milk fever when injected for a number of days pre- and post-partum. These results obviously were never reported in the literature.

During this period, Dr. W. W. Dimock, along with his associates at the University of Kentucky, E. R. Doll, P. R. Edwards and D. W. Bruner did much to elucidate the reproductive causes for infertility and abortion in mares. Dr. Bruner later taught microbiology at Cornell and became an expert on salmonellosis, especially salmonella abortion in mares. These researchers worked closely with the early practicing veterinarians near Lexington, Kentucky such as C. E. Hagyard and E. A. Caslick. Dr. Dimock was a tall, quiet, extremely capable gentleman and equine reproductive clinician who, when he relaxed and talked with a group after a good dinner, could relate some of the most humorous stories I have ever heard. Dr. E. A. (Ed) Caslick was raised on a farm a few miles southwest of Ithaca, N.Y. He was an excellent, indefatigable equine veterinarian who kept extremely detailed accurate records on many Thoroughbred mares in his practice. In 1937 he published a paper in the "Cornell Veterinarian" that stands today as one of the best, most thorough and classic clinical study and description of the equine estrous cycle in the veterinary literature. In the same issue he described the vulva-suturing "Caslick" operation which is still the most widely employed surgical technique in mares and cows to correct infertilty caused by pneumovagina.[29a,29b] As with the genetic aspects of cystic ovaries in cattle, one should speculate on what the future reproductive efficiency of the Thoroughbred breed might presently be if this operation was not introduced and those infertile mares with conformational perineal defects had been eliminated.

Two outstanding practicing veterinarians in the 20's through 40's in the Northeast were Drs. Cassius Way and Earle B. Hopper who had been students under Dr. W.L. Williams. Dr. Way was an equine reproduction and surgical specialist. He introduced the equine ovarian needle, inserted through the vagina to tap and drain ovarian "cysts" to "correct" infertility in mares. In the early 50's this practice was discontinued when pathologists such as K. McEntee and others demonstrated that equine ovaries did not develop "cysts" as occurred in cattle and that normal equine ovarian follicles could vary in size from 1 to 5 inches (2.5 to 10 cm) in diameter. However the draining of 2 to 5 ounces of follicular fluid into a glass container was a dramatic procedure and as we all know nature, not man, "cures" many cases of infertility.

Dr. Earle Hopper of Ridgewood, NJ was a veterinary consultant practicing preventive medicine including reproduction in many valuable purebred Guernsey herds in the northeastern states. Dr. Hopper and his son, also a veterinarian, were long-time, close friends of mine. The former was a highly intelligent, athletic, aggressive and opinionated veterinarian and polo player. He had a very highly developed capacity to remember cattle pedigrees and animals he had seen or treated. He also developed the Hopper bovine cervical vulsellum forceps to retract the cervix and uterus. On several occasions he related to me a visit he made to the King Ranch in Texas to buy some Quarter horses for a New England client. While there he listened to an illustrated lecture on the origin and development of the Santa Gertrudis breed of cattle by the crossing of Shorthorn and Brahma cattle. During this lecture they showed the picture of the noted "Monkey" bull that was very influential in establishing the breed. He knew he had previously seen the bull and after some thought remembered he had been called by a veterinary classmate to the Clifton, NJ Quarentine Station 20 or 30 years before, to help test a "real mean, big, red bull." On looking at the waybill accompanying the bull he noted the bull was a Sindhi bull from East Africa consigned

to the King Ranch in Texas. (An interesting story if correct, but Dr. Hopper was certain of his facts).[37]

It is appropriate and important to point out that in the late 30's and 40's the field of animal and human reproductive science and endocrinology was expanding very rapidly with much research support by both state and federal governments. It became the overt policy of the then Bureau of Animal Industry and the U.S. Dept. of Agriculture that research funds for reproductive pathology and microbiology in food-producing animals was the province of veterinary medicine. But funds for research in animal physiology, "altered" physiology, endocrinology, nutrition, and reproductive management including artificial insemination, went to the animal science departments and experiment stations of agricultural colleges.[35] This policy, lasting to the present, has had a significant and profound effect on the role of the veterinarian in animal reproduction. This policy has required the close association of both animal science and veterinary medicine to advance the field of animal reproduction even though administratively these areas of research have been largely separate for the past 45 years. Within these past 45 years animal scientists in many agricultural research stations and departments have conducted extensive reproductive studies in physiology and endocrinology, artificial insemination and embryo transfer, nutrition, animal behavior and management in both the food-producing and pet animals that have been of enormous value to the animal owners and veterinarians. We in theriogenology are greatly indebted to them. Drs. J. T. Reid and S. E. Smith of Cornell, J. N. Wiltbank of Colorado and the USDA and others have conclusively shown the marked influence nutrition has on growth and puberty, the estrous cycle and fertility of animals. "Reproduction is a luxury function". Any adverse long term detrimental influence in an animal, especially a nutritional one, depresses reproductive functions.

In the 1940's and 1950's I was favored by being at Cornell and working with noted reproductive scientists in the Dept. of Animal Science of the College of Agriculture, including S. A. Asdell who published the encyclopedic text "Patterns of Mammalian Reproduction"[32] and his associates G. W. Trimberger, Glenn W. Salisbury, N. L. VanDemark, R. H. Foote and William Hansel who have published widely and carved notable careers for themselves and trained many in our present generation of researchers in the reproductive field such as William C. Wagner and M. R. Jainudeen, both students of mine, Harold Hafs, formerly of Michigan State, P. F. Concannon and many others.[15,36,51,65,66,73] Another colleague was Dr. F. B. Hutt, a fine animal geneticist with a wry sense of humor who has written widely in more recent years on the inherited defects or anomalies of domestic animals including the dog.[33,34] All of the above scientists in the reproductive field were practical physiologists, some in endocrinology such as Drs. Bill Hansel and Harold Hafs, others in artificial insemination including Drs. Trimberger, Salisbury, Van Demark and Foote. These men and others like them introduced scientific and experimental methods including statistics and controlled studies which have done much to extend and elevate the applied science of theriogenology. Theriogenologists owe them a great debt.

I had been in Vermont for less than a year when a former student in a nearby veterinary practice called and stated a client of his had the highest producing Jersey cow in the Northeast but she would not conceive because of repeatedly having cycles

of 8 to 10 days in length. I recalled a seminar and paper given 13 years before by Drs. William Hansel and William Wagner (a member of our Vet. College bowling team) that stated that repeated daily injections of oxytocin would cause such a syndrome of failure of luteal function.[48] Upon inquiry this was what the owner was giving twice a day to cause milk "let down" in this high-producing cow. Many examples of the value of many non-veterinary scientist's studies could similarly be cited by all of us.

In 1961 Drs.Salisbury and VanDemark collaborated in publishing the outstanding text, "Physiology of Reproduction and Artifical Inseminaton of Cattle".[38] As a student at Cornell in the late 30's I still vividly recall Glenn Salisbury, who as a young instructor teaching our veterinary class in "Feeds and Feeding" threw chalk and erasers at dozing members of the class. You had to stay awake or get hit! Also during this period Dr. James A.Henderson, later one of the authors of the encyclopedic book "Veterinary Medicine", was a graduate student of Dr. M. G. Fincher. The following year he became the manager of the first AI bull stud in New York State, the "Pioneer Stud" in Dryden, N.Y.

In 1944, Dr. L. E. Casida and his coworkers at the University of Wisconsin reported on the first highly successful treatment of cystic ovaries in cattle with a sheep pituitary extract rich in LH that later was produced commercially as "Vetrophin".[38] Prior to the development of this product, and later HCG and GnRH, the only treatment was repeated manual removal of the cysts. After being a "student" of Dr. W. L. Williams I have often speculated that if no highly successful treatments for cystic ovaries in cattle had been developed would we now have the very high, incidence of the disease in dairy cattle which definitely has a genetic component? In the late 40's and 50's Dr. Casida and others, including Bearden, at Cornell performed and reported on a number of detailed, classical studies in cattle on fertilization failure, embryonic death and repeat breeders.[15] It was unfortunate at the time that we did not recognize the widespread repeat-breeder problem was, to an unknown extent, caused by vibriosis, now called campylobacteriosis. This disease was undoubtedly spread widely by artifical insemination with vibrio-contaminated liquid semen from infected bulls. In the late 1960's to the present Dr. N. Ayalon of Israel and others[15,81] have completed further more sophisticated studies on the continuing problem of repeat-breeders with informative observations based on embryo transfer and other techniques.

Although campylobacteriosis (vibriosis) as a cause of abortion due to C. fetus venerealis in cattle and C. fetus intestinalis in sheep was reported as early as 1910 to 1920 by Theobald Smith and other federal veterinarians, it wasn't until the late 1940's and 50's that European veterinarians such as H. C. Adler, A. Florent and N. O. Rasbech and American veterinarians including A. H. Frank, J.H. Bryner, and H. L. Gilman[15] discovered and reported extensively on the fact that this disease was a major cause of early embryonic death and infertility in cattle. A study by J. O. Almquist of Pennsylvania State College reported on the beneficial effects on bovine fertility of adding certain antibiotics (penicillin, streptomycin and sulfanilimide) to semen used in artificial insemination.[39] The connection between these reports appeared obvious and H. L.Gilman and D. E. Hughes and coworkers showed these antibiotics would eliminate vibrios from infective liquid semen and not damage spermatozoa.[40] During this period and into the early 1960's Drs. Wayne Plastridge of

Connecticut, John Kendrick of California and A. B. (Al) Hoerlein of Colorado who studied this disease further, developed techniques for culturing the rather fastidious organism and by serological methods detected its presence in vaginal and cervical mucus. Dr. Hoerlein and his coworkers subsequently developed bacterins that have been highly effective in immunizing cattle and sheep against vibriosis (campylobacteriosis), Dr. Hoerlein, a highly competent microbiologist obtained his Ph.D. degree at Cornell as well as his wife, Charlotte Morehouse, an attractive, pleasant brunette, who came from Interlaken, a small town near Ithaca. N.Y.

In the late 1950's I had the great pleasure of hosting the late Dr. Wadislaw Bielanski, a noted equine theriogenologist of Krakow, Poland, for a visit of several months at Cornell. Dr. Bielanski had published extensively on semen evaluation and fertility in stallions based on his studies with the Polish National Stud.[41] He imparted his extensive knowledge and experience freely including his dislike of Russians, the latter probably enhanced by his being an officer in the Polish cavalry. On a short excursion to Niagara Falls we rode a local bus in Buffalo, N.Y. This city has a large Polish population and when the Polish riders on the bus heard that Dr. Bielanski was from Poland and would be returning there shortly they practically stopped the bus, bombarded him with questions in Polish and gave him lists of relatives to contact on his return. This he very graciously, and with deep feelings, agreed to do. On another occasion we visited a large (250 acre) well-managed Holstein dairy owned and operated by the Fedorka's, a Polish family. Following our visit we had a glass of homemade wine and cookies and "Polish" conversation with the family matriarch "Julia". She with her husband had come to the U.S. after World War I. They could speak no English and worked as caretakers in an apartment house in N.Y. City for 10 years and finally bought a small farm north of Ithaca and had greatly enlarged it over the years with the help of their two sons. I noticed Dr. Bielanski silently crying on our way back to the College. After he had composed himself he said, "That farm and those people characterize what we Poles think of America, the land of opportunity! That could never happen in Poland!"

The Department of Clinical Sciences at Colorado State University has been closely associated with the development of theriogenology and the organization of veterinary scientists and practitioners in this field from the 1940's to the present. Northern Colorado and Wyoming experienced severe blizzard conditions in the winter of 1949-50 resulting in the deaths of thousands of cattle, sheep and horses along with severe frostbite to the scrotum of many range bulls.[3,4,6] Prior to the next breeding season Drs. Harold J. Hill, Lloyd C. Faulkner and others of the clinical staff at C.S.U. were requested to assist some practitioners, including G. W. Cooper of Roggin, Colorado, in evaluating the breeding soundness of the bulls on some ranches including that of Mr. Stafford Painter, a progressive politically-active and influential rancher and a client of Dr. Cooper's. (I later came to know and respect Dr. Cooper, a black veterinarian, during an extended visit to Cornell before he assumed his responsibilities in the Veterinary College Clinics of the Veterinary College at Tuskegee). Mr. Painter, Dr. Cooper's client, became convinced of the economic benefits of bull evaluation for commercial ranchers and secured a legislative grant for equipment and a mobile laboratory for C.S.U. This became the Colorado Bull Testing Program or Service that started in 1953-1954 and continued for many years thereafter. Thus, "It is an ill-wind

that does not blow someone good!" The excellent reports, clinics, research, techniques and standards developed by the personnel of this program became "landmarks in breeding soundness evaluation of bulls".[1-7]

Dr. H. J. Hill, an energetic, highly capable, but unpredictable, veterinary scientist at C.S.U. gave the initial idea and impetus to the formation of a veterinary society called "The Rocky Mountain Society for the Study of Breeding Soundness of Bulls" established in 1954. Later in the 1960's this organization became the "American Society for the Study of Breeding Soundness of Bulls", which later in the early 1970's, under the leadership of Dr. John Simons of Torrington, Wyoming, became our present Society for Theriogenology. According to Dr. Les Ball, the name of "Society for Theriogenology" was chosen instead of the "Society of Theriogenology" because the abbreviation of the latter title (SOT) had serious detrimental connotations. The above former early societies published a journal sporadically, "When the spirit moved and time permitted". The late E. J. (Ed) Carroll and later James (Jim) Scott were early secretaries of these Societies as well as supervisors of the Bull Testing Program. In the late 1950's in conjunction with an electronics firm in Denver the W. G. R. Marden electroejaculator was developed which enabled many more bulls to be evaluated daily. Dr. Les Ball provided me much more fascinating historical data and material on this Program, the early Societies it spawned and the veterinary scientists involved including such items as "Nandi" the sacred bull that became the symbol or logo of this Society. This history should be collated and presented to this Society by one of the participants of the above Program and the early Societies in a future Bartlett Address.

One day in Southpark, Colorado, when I was assisting the late Dr. Ed Carroll evaluating bulls, I was climbing the chute and performing scrotal and rectal examinations while Ed was ejaculating bulls and checking their semen. After about 10 bulls I remarked I was exhausted, must be badly out of condition and needed a rest. Ed laughed and offered to trade "jobs" with me indicating my "flatlander" problem was due to the fact we were at an elevation of 10,000 feet! A statement was made in an early journal of the Rocky Mountain Society for the Study of Breeding Soundness of Bulls,[4] "This service can't guarantee a bull to be absolutely capable of bringing about conception in females. However it is possible to state that the semen of a bull is not capable of causing conception." Which reminded me of a much shorter statement by Nils Lagerlof of Sweden that "one should never indicate that a bull is fertile but only that no reason can be found to indicate it is not fertile!"[42] In the intervening years to the present Colorado State University has grealy expanded its studies in animal reproduction to encompass artificial insemination of horses, genital diseases of cows as well as bulls, pregnancy diagnosis and embryo transfer in cattle and horses. Currently it is one of the leaders in the field of theriogenology in the U.S. Some of its noted present faculty include William (Bill) Pickett, R. Shideler, J. L. Voss, R. Mortimer, J. D. and P. N. Olson, L. Ball, R.P. Elsden, G.E. Seidel, Jr. and E. L. Squires.

Other outstanding veterinary clinicians and practitioners in the 50's through 70's that contributed significantly to the knowledge base and advancement of bovine theriogenology were Raimunds Zemjanis, Elmer Woelffer, Lloyd Faulkner and our European colleagues G. H. Arthur of England, A. Bane and Ingemar Settergren of

Sweden, Erik Blom of Denmark and C. H. W. deBois of the Netherlands. Dr. Raimunds Zemjanis of the University of Minnesota has been a vigorous promoter and organizer of theriogenology and herd reproductive examinations.[8] His book "Diagnostic and Therapeutic Techniques in Animal Reproduction" has been a classical clinical manual for the reproductive examination of cows and mares.[43] This author has found that all students of "Ray" Zemjanis had an excellent "grasp" of practical reproductive diagnostics. At a summer conference on animal reproduction organized by Kurt Benirschke at Dartmouth College in Hanover, New Hampshire, in the early 60's, "Ray" and Al and Charlotte Hoerlein stayed with my wife and me at our summer cottage on a nearby lake in Andover, NH. When I arose one morning "Ray" was out on the dock in the early morning mist shaving. To indicate his competence, manual dexterity and "touch" he had no facial nicks even using cold water, a rippling mirror and a straight razor on tough, dark whiskers!

Elmer Woelffer of Oconomowoc, Wisconsin, conducted a highly competent, consultive and ethical bovine reproductive practice for many years and was editor of the veterinary page in Hoards Dairymen monthly magazine, which was widely read by thousands of dairy farmers throughout the United States. This page, under the editorship of Dr. Woelffer and his fine successors, has done much to raise the prestige of our profession and acquaint dairy farmers with new applied reproductive knowledge and services available from veterinarians.

Dr. G.H. Arthur of England has continued his practical and scholarly revisions of the texts on veterinary obstetrics initially authored by J. G. Wright and F. Benesch.[9] Drs. A. Bane, I. Gustavsson and Ingemar Settergren of Sweden have carried out many basic and applied studies of the same high quality and standards set by their mentor, N. Lagerlof, in bovine infertility problems, in ovarian hypoplasia, cytogenetics and Robertsonian translocations. We, at Cornell, were particularly fortunate, under the leadership of K. McEntee, to have Dr. Settergren spend a year or more with us providing us the benefit of his keen analytical mind, experience and knowledge of European reproductive research. Similarly, Erik Blom and his coworkers in Denmark have made many important contributions to theriogenology in areas of artificial insemination, semen studies and infertility in bulls.[77,78]

During the 60's the outstanding veterinary clinic at Utrecht, Netherlands led by Professor Dr. C. H. W. deBois and his coworkers further defined and improved the techniques of fetotomy and caesarean section favored by the yearly large numbers of bovine dystocias in that country's dual purpose Friesian cattle. In the early 70's the early history of the 20's repeated itself and these techniques were widely disseminated in the U.S. by Drs. C. J. Bierschwal 46 of Missouri[44] and L. Ball of Colorado who spent sabbatic leaves in Utrecht. When Dr. deBois can perform a complete bovine fetotomy in a large heifer within 20 to 30 minutes, we all should take notice!

Veterinarians in equine practice in the 40's to the 70's that have also significantly advanced the knowledge of theriogenology and the respect of horse owners for veterinary reproductive science have been Floyd Sager, John Hughes, Robert G. Loy, William R. McGee, Robert M. Kenney, M. R. Vandeplassche of Ghent, Belgium, and Virginia Osborne of Australia. Col. or Dr. Floyd Sager of Lexington, Kentucky, has

appeared before many lay and veterinary groups throughout the U.S. and imparted his practical experience and wisdom based on 65 years in the equine breeding industry. Dr. Sager's judgement and knowledge is only exceeded by his prodigious memory. On a long visit with Dr. Sager at Claiborne Farm in the early 1960's, I asked him how many completely sterile stallions he had known that had an opportunity to breed a number of normal mares. After about 10 minutes of contemplation he indicated and named four sterile stallions. These, he said, were out of about 5,000 stallions he had known (an incidence of 0.008 percent!).

Dr. John Hughes of California, a highly respected, scholarly, clinically-able horseman and professor has also published widely on the pathophysiology of equine infectious genital diseases, and infertility in mares due to cytogenetic defects. Dr. William R. McGee, Robert G. Loy of Kentucky and Robert M. Kenney have published and spoken to many groups on practical aspects of equine theriogenology. Drs. Loy and Kenney performed significant research studies in the 60's and 70's on the effects of certain hormones and light on the estrous cycle of mares and endometrial pathology and andrology, respectively.[15,60,61] Dr. M. R. Vandeplassche and his coworkers in Ghent, Belgium, have described improved successful techniques for caesarean operations in mares and cows and compared these results with fetotomy operations.[15] Prior to this period only occasional successful caesarean operations on mares had been reported. Virginia E. Osborne, an Australian veterinary anatomist, and pathologist, a close friend and colleague of mine, as well as Professors K. McEntee and Robert Habel of Cornell and R.W. Allen of Cambridge, England, has conclusively demonstrated that the physiologic breeding season of the mare does not coincide with the "official" breeding season of the racing breeds established in 1833 in England to accommodate the racetrack stewards. This tradition thus results in much unnecessary apparent infertilty in these breeds.[15,68]

Although prior mention has been made of some of the early workers that developed the science of artificial insemination that has made possible extensive progeny testing, explored techniques in the detection of estrus, estrous synchronization, and the great advances in the productivity of the food producing animals, further recognition should be given to them and others who pioneered and developed AI including frozen semen in all of our domestic animals and many wild animal species. These outstanding animal scientists include R. H. Foote, G. W. Salisbury, N. L. VanDemark, J. O. Almquist, E. J. Perry, D. Bartlett, and G. W.Trimberger, who played an early significant role plus many other more recent workers in cattle and other species including felines, poultry, wild animals and even alligators such as: C. Polge, L. L. Larson, R. P. Amann, B. W. Pickett, E. F. Graham, F. I. Elliott, D.R.Melrose, J. C. Corteel, S. Salamon, M. Shelton, A. E. Harrop, R. W. Kirk, S. W. J. Seager, C. C. Platz, N. J.Sojka, P.F. Watson, D. Wildt, and P. T. Cardeilhac and T. Lane.[15,36,39,46,47, 49,53,54,66,75,80]

Although the transfer of fertilized ova or embryos was reported in laboratory animals nearly a hundred years ago, it was not until 1951 that the Wisconsin workers reported the first successful surgical embryo transfer in cattle. It was further developed as an important and continuing research "tool" in domestic ruminants. With the introduction of the exotic European beef breeds into the U.S. in the early 70's, embryo transfer, freezing and manipulation of embryos, including sexing and splitting of embryos, and their shipment was employed as means of spreading and utilizing more rapidly this genetic material and to avoid the introduction of foreign diseases into the U.S. Although embryo transfer, similar to artificial insemination, finds its widest application in the cattle, it has recently been extended to the other domestic animals including swine, sheep, horses, including the female mule as a recipient animal! by R. W. "Twink" Allen of Cambridge, England and D. F. (Doug) Antczak the latter an immunologist and a former student and captain of one of my polo teams at Cornell. Unfortunately there are some limiting problems with the emerging speciality of embryo transfer such as unreliable donor responses to superovulation, the economic costs involved and the inability to adequately progeny test the donor female. Those scientists and veterinarians, in the research and applied areas that have performed a significant role in extending the practice of embryo transfer in recent years include: R. P. Elsden, E. L. Squires and G. E. Seidel, Jr. of Colorado, M. Drost of Florida, R. J. Mapletoft of Canada and (Joe) J. M. Wright, a former graduate student of mine, of Texas, O. J. Ginther and G. L. Woods of Wisconsin and Cornell.[15,79,88]

Many excellent books, monographs and seminar articles have been published in the field of theriogenology over the past 30 years. These publications have further consolidated and defined the field of theriogenology into a recognized specialty. In the mid-60's the timely review "Abortion Diseases in Livestock" edited by Lloyd Faulkner[45] was one of the forerunners of a number of subsequent multi-authored books. This trend, which has increased in recent years, has reflected the degree of expansion of knowledge and the number of species and discipline-oriented specialties within theriogenology. (See Figure 1). H. H. Cole and P. T. Cupps of California have edited three editions (1959-1977) of their excellent basic science text "Reproduction in Domestic Animals"[15,46] which includes an historical chapter by S. A. Asdell. Other chapters on endocrinology, spermatogenesis by R. Ortavant of France, and reproduction in horses, dogs, cats, cattle and pigs by G. H. Stabenfeldt, J. P. Hughes, V. M. Shille, T. J. Robinson of Australia and P. J. Dzuik, respectively, are outstanding. Dr. D. A. Morrow of Michigan, a former student and graduate student of mine of whom I am very proud, has edited the text "Current Therapy in Theriogenology".[49] Dr. Morrow's organizational and persuasive abilities in collecting the extensive material from numerous authors must be admired. Another quality multi-authored text is "Reproduction in Farm Animals"[47] 1st through 4th editions, 1962-1980, by E. S. E. Hafez with outstanding chapters on sheep and goat reproduction by C. V. Hulet of Idaho and M. Shelton of Texas, and artificial insemination by R. H. Foote of Cornell. An established reference book that has gone thru three editions (1963-1985) is "Pathology of Domestic Animals"[57] edited by Drs. K. V. F. Jubb, Peter C. Kennedy and N. Palmer. The former two editors were outstanding graduate students of Dr. Peter Olafson, my highly esteemed colleague at Cornell. The chapters on reproductive pathology in the third volume were contributed by Dr. K. McEntee, a former student, an excellent reproductive scholar and pathologist, and close coworker of mine for many years at Cornell who is now at the University of Illinois and to whom I am indebted for many illustrations in my text book. Multi-authored symposia proceedings edited by I.W. Rowlands and R. W. Allen[60] of England on equine reproduction in 1975, 1979 and 1983, have been published in book form as supplements of the "Journal of Reproduction and Fertility" and are excellent sources of much current information and research in this field.

Other current excellent texts or material in the field of theriogenology that further establish, define and review our current knowledge are; "Infectious Diseases of Domestic Animals"[50] (1951-1981) by W. A. Hagan, D. W. Bruner, J. H. Gillespie and J. F. Timoney. and "Veterinary Medicine"[52] (1960-1980) by D. C. Blood, J. A. Henderson and O. M. Radostits. I have mentioned my relationship and respect for Jim Henderson. Doug Blood worked as a diligent and keen ambulatory clinician at Cornell for a number of years after coming from Australia before going to the Ontario Veterinary College and later to a deanship at Melbourne, Australia, where he continued his concern for applied clinical and farm economic veterinary medicine. Doug had a Cockney accent that was promptly noted by our New York State farmers. He would reply "Yes, I'm an Austrylian. Here in the States you call a bison a buffalo, in 'Austrylia' we wash our face in it."

Other excellent practical texts in the modern field of theriogenology include: "Equine Stud Farm Medicine"[59] (1980) by P. D. Rossdale and S.W. Ricketts of England; "Handbook of Bovine Obstetrics"[63] (1980) by V.Sloss and J.H. Dufty of Australia; "Reproductive Biology of the Mare"[61] (1979) by O. J. Ginther; "Veterinary Obstetrics and Genital Diseaes (Theriogenology)[15] (1965-1985) by S. J. Roberts; "Bovine and Equine Urogenital Surgery"[62] (1980) by D. F. Walker and J. T. Vaughan; "Veterinary Endocrinology and Reproduction"[58] (1975) by L. E. McDonald; "Equine Reproduction[70] (1983) (a monograph) by D. P. Neely, I. K. M. Lui and R. B. Hillman; Society of Theriogenology Manuals[64] on Bulls, Canine, Broodmares, Stallions, Boars, Sheep and Goats, by reproductive specialists working with those species including L. Ball, R. Ott, R. Mortimer, J. Simons; S. Johnston, R. Larson, P. Olson; W. McGee, R. Pierson, J. K. Ward, J. Gloyd, D. Meirs, D. Witherspoon, R. M. Kenney and J. Hurtgen and M. A. Memon respectively; "Goat Production"[53] (1981) by C. Gall; "Diseases of Swine"[54] (1981) by A. D. Leman (and other authors); "Diseases of Sheep"[56] (1982) by R. Jensen and B. L. Swift; and other current historical and review material on theriogenology may also be found in the 75th Anniversary Issue of the Cornell Veterinarian, January 1985 75, 1. and in the 75th Jubilee Issue of the Journal of Animal Science 57 Suppl. 2, July 1983.

Besides the current numerous general and disciplinary veterinary and animal science journals containing articles in the field of theriogenology, the field has two journals of its own: "Theriogenology," initiated and edited formerly by the late John W. Kendrick in California another highly respected student of mine and presently edited by Victor M. Shille of Florida, is in its 23rd volume and published by Geron-X Inc., Los Altos, Calif. and "Journal of Reproduction and Fertility" of 7 Downing Place, Cambridge, CB2 3EL England. Other current sources of excellent review articles in theriogenology are the annual proceedings of the species specialties such as AABP, AAEP, AAHA, Sheep and Goat, Swine, Zoo, Feline, Laboratory Animal, Wildlife, and aquatic Veterinary Organizations including the U.S. Animal Health Association. Such voluminous, outstanding, scholarly, current material on theriogenology from this Society for Theriogenology and the American College of Theriogenologists has definitely established this field as a research and clinical specialty that is highly important and thriving. The future appears secure as long as the above societies work together to mold basic and applied knowledge for the benefit of both animals and man.

Other disciplinary fields such as microbiology and immunology also have their marked impact on theriogenology. It is more than coincidence that in recent years a variety of similar infectious, ubiquitous organisms have been recently reported to be the cause of disease, or found regularly, in the respiratory, ocular and reproductive tracts. This coincidence has been further impressed on me by the presence of protective lymphoid tissues in the body orifices including the vulva, prepuce, pharynx, and third eyelid. These similar infectious agents causing follicular vulvitis, pharyngitis and conjunctivitis and other reproductive and respiratory and ocular diseases, include the mycoplasmas, ureaplasmas and hemophilus organisms which have been described by P. A. Doig, H. L. Ruhnke and R. B. Miller of Canada,[78]; IBR, IPV, BVD and equine herpes viruses reported on by R. F. Kahrs, J. W. Kendrick, D. G. McKercher and J. T. Bryans and G. P. Allen[15,83] and others at Cornell,[65] California and Kentucky, respectively; and chlamydial organisms (EBA) by Storz of Colorado and McKercher and coworkers in California.[15]

Other microbiologists including K.L. Fennestad of Denmark, W. A. Ellis and E. A. Wrathall of England and L.E. Hanson and O. H. Stalheim of the U.S. have greatly increased our knowledge and control of leptospiral abortion in all species of animals. In recent years P. J. Timoney and D. G. Powell of the British Isles and J. T. Bryans have greatly assisted theriogenologists in the treatment and control of contagious equine metritis and equine viral arteritis.[15,50] In swine, the pioneering work in the 1960's of H. W. Dunne of Pennsylvania on the SMEDI (Stillbirth, Mummification, Embryonic Death and Infertility) viruses including the enteroviruses, pseudorabies virus and parvovirus has been greatly expanded by Drs. K. Wohlgemuth, W.L. Mengeling, D. P. Gustafson, L. E. Hanson and others in the midwest to the benefit of the swine industry.

A newly emerging important, specie in our field is the water buffalo which is one of the numerically largest species of ruminant in the world.[69,73] The theriogenological aspects of this specie has recently been described by my friend and respected colleague, M. R. Jainudeen of Malaysia. Dr. Jainudeen, who was a veterinary graduate student from Ceylon (Sri Lanka) under myself (MS) and Dr. William Hansel (PhD) at Cornell and later a colleague of E. S.E. Hafez, is a highly intelligent, friendly, enthusiastic, energetic veterinarian, who has made many friends. In Ceylon he had worked with elephants and when asked by other students about copulation in elephants remarked "It is not an act; it is an engineering feat".

I apologize for not noting many other veterinarians and scientists that have contributed significantly to theriogenology these past 75 years. Time and space limitations for this Address as well as the limitations of my acquaintances, reading and comprehension have further reduced the deserved recognition of many that have been responsible for the growth and evolution of the science and art of theriogenology. As you can sense from this presentation I like people especially those who are knowledgeable and communicative, with stimulating ideas. Fortunately, most theriogenologists fit this mold! Since I have been personally acquainted with over three-quarters of those theriogenologists mentioned in this Address, I am inclined, as others before me, to believe I have lived in the "Golden Age" of theriogenology. As

one old Vermonter said to me on a recent gorgeous Fall morning, "Sure glad I didn't die yesterday!".

The marriage of the Society for Theriogenology with the American College of Theriogenologists has been a significant, fortuitous and fruitful one, for which many were matchmakers. The two-way flow and interchange of knowledge between the clinical, practical or applied areas and the theoretical or basic ones best promote the goals of both organizations as well as benefiting animal owners and society. Each discipline and species in our field have basic and applied inter-related aspects that complement each other. Theriogenology probably has the greatest breadth and depth and challenge of any field in the biological sciences (Figure I). Dr. W. W. Williams stated, "Great contributions have been made by various persons and organizations yet it is very evident that much greater progress might result if more attention were given to the evaluation of new ideas, hypotheses and researches in terms of their scientific merit and their ethical applicability."

References

1. Ball, L. (1985) Personal Communication.
2. Carroll, E. J., Ball, L. and Scott, J. A. (1963) Breeding Soundness in Bulls -A Summary of 10,940 Examinations, JAVMA, 142 1105-111.
3. Faulkner, L. C., Hopwood, M. L., Masken, J.F., Kingman, H. E. and Stoddard, H.L. (1967) Scrotal Frostbite in Bulls, JAVMA 151, 5,602-605.
4. Hill, H.J., Kingman, H.E., Faulkner, L.C. et al (1954,1955) Study of Breeding Soundness of Bulls, J. Rocky Mountain Soc. 4, 1; 5, 1,2, 1-35.
5. Hill, H.J. (1956) Morphology of Bovine Semen and its Relative Importance in the Evaluation of Breeding Soundness, Jour. of the Amer. Vet. Soc. for Study of Breeding Soundness, 6, 2,
6. Hill, H.J. (1958) Breeding Soundness of Bulls, Vet. Med. 53, 189
7. Ball, L. and Carroll, E.J. (1961) Evaluation of Bulls for Breeding Soundness - A Summary of Seven Years' Work at Colorado State University (1954-1961), J. of Soc. for Study of Breeding Soundness of Bulls, 9, 4, 1-36.
8. Bartlett, D.E. (1984) Theriogenology from Concept to Actuality, Proc. Ann. Mtg. Soc. for Theriogenology, Denver, 221-234.
9. Arthur, G.H. (1964) "Wright's Veterinary Obstetrics", 3rd Ed., Bailliere Tindall and Cox, London and (1975) "Veterinary Reproduction and Obstetrics", 4th Ed.
10. Benesch, F. (1926) Tutocaine and Epidural Anesthesia, Cor. Vet. 16, 3,227.
11. Benesch, F. (1952) "Lehrbuch der Tierarztlichen Geburtshilfe und Gynakologie", Urban and Schwartzenberg, Wien-Innsbruck, Austria.
12. Craig, J.F. (1918) "Fleming's Veterinary Obstetrics," 3rd Ed., Alex, Eger Co., Chicago, Ill.
13. Williams, W.L. (1943) "The Diseases of the Genital Organs of Domestic Animals," 3rd Ed., Publ. by author, Ithaca, N.Y.
14. Williams, W.L. (1943) "Veterinary Obstetrics", 4th Ed., Publ. by author, Ithaca, N.Y.

15. Roberts, S.J. (1956,1971,1985) 1st and 2nd Edit., 3rd in press. "Veterinary Obstetrics and Genital Diseases (Theriogenology)", Publ. by the author, Woodstock, VT.
16a. Richter, J. and Gotze, R. (1950, 1960) "Lehrbruch der Tiergeburtshilfe", H. Laupp Jr., Tubingen, Germany. 2nd Ed. Paul Parey, Berlin, Germany.
16b. Tavernier, H. (1955) "Guide de Practique Obstetricale chex las Grandes Femelles Domestiques", Vigot Ferers, Paris, France.
17. Bang, B. (1897) Aetiologie des Infectiosen Verwerfens, Zeitschrift fur Tiermedicin, 1, 241.
18. Albrechtsen, J. (1917) Sterilty of Cattle and Methods of Treatment, Cor. Vet. 7, 3, 169.
19. Leonard, E.P. (1979) "A Cornell Heritage: Veterinary Medicine 1868-1908", Publ. by author, Ithaca, N.Y.
20. Leonard, E.P. (1982) "In the James Law Tradition 1908-1948", publ. by N.Y.S. Coll. of Vet. Med., Ithaca, N.Y.
21. Williams, W.W. (1984 and 1985) Personal Communications to Dr.David Bartlett, and S. J. Roberts.
22. Williams, W.W. and Savage, A. (1925) Observations on the Seminal Micropathology of Bulls, Cor. Vet. 15, 353.
23. Williams, W.W. and Savage, A. (1927) Methods of Determining the Reproductive Health and Fertilty of Bulls, Cor. Vet. 17, 374.
24. Williams, W.W. (1920) Technique of Collecting Semen for Laboratory Examination, Cor. Vet. 10, 2, 87-93.
25. Blom, E. (1984) Personal Communication.
26. Lagerlof, N. (1938) Infertility in Male Domestic Animals, Proc. 13th Internat. Vet. Congr. 1, 214.
27. Lagerlof, N. (1934) Morphologische Untersuchungen uber Veranderungen in Spermabild und in den Hoden bei Bullen mit Vesminderter oder Aufgebabener Fertilitat, Acta Pathol. et Microbiol. Scand. Suppl. XIX
28. Emmerson, M.A. (1932) Trichomoniasis in Cattle, JAVMA, 81, 636.
29a. Caslick, E.A. (1937) The Vulva and the Vulva-vaginal Orifice and its Relation to Genital Health of the Thoroughbred Mare. Cor. Vet. 27,2, 178.
29b. Caslick, E.A. (1937) The Sexual Cycle and its Relation to Ovulation with Breeding Records of the Thoroughbred Mare, Cor. Vet. 27, 2, 187.
30. Frank, E.R. and Roberts, S.J. (1940) Caesarean Section in the Bovine, N. Amer. Vet. 21, 9, 546.
31. Roberts, S. J.and Frank, E.R. (1942) Further Observations on the Caesarean Section in the Bovine, Cor.Vet. 32, 4, 395.
32. Asdell, S.A. (1946, 1964) "Patterns of Mammalian Reproduction", (Ist & 2nd Editions), Comstock Publ. Co., Ithaca, N.Y.
33. Hutt, F.B. (1964) "Animal Genetics", Ronald Press Co., N.Y.C.
34. Hutt, F.B. (1979) "Genetics for Dog Breeders", W.H. Freeman, San Francisco.
35. Bartlett, D.E. (1984) Personal Communication.
36. Salisbury, G.W. and VanDemark, N.L. (1961, 1978) "Physiology of Reproduction and Artificial Insemination of Cattle", (Ist & 2nd Editions), W.H. Freeman Co., San Francisco, CA
37. Hopper, E. (1962) Personal Communication.

38. Casida, L.E., McShan, W.H. and Meyer, R.K. (1944) Effects of an Unfractionated Pituitary Extract upon Cystic Ovaries and Nymphomania in Cows, J. of An. Sci., 3, 3, 273.
39. Almquist, J.O. (1951) A Comparison of Penicillin, Streptomycin and Sulphanilamide for Improving the Fertility of Semen from Bulls of Low Fertility, J. Dairy Sci. 34, 819.
40. Orthey, A.E. and Gilman,H.L. (1954) The Antibacterial Action of Penicillin and Streptomycin against Vibrio fetus in Semen, J.Dairy Sci. 37, 4, 407-416.
41. Bielanski, W. (1963) Die Kunstliebe Besamung bein Pferd in Die Kunstliche Besamung bei den Haustieren, Schaetz, F., Gustav Fischer Verlag, Jena, Germany.
42. Lagerlof, N. (1960) Personal Communication.
43. Zemjanis, R. (1970) "Diagnostic and Therapeutic Techniques in Animal Reproduction", Williams, Wilkins, Co. Baltimore, MD.
44. Bierschwal, C.J. and DeBois, C.H.W. Prof. dr. (1972) "The Techniques of Fetotomy in Large Animals", V.M. Publ.Co., Bonner Springs, KS.
45. Faulkner, L.C. (1968) "Abortion Diseases of Livestock", C.C. Thomas, Publ. Springfield, ILL.
46. Cole, H.H. and Cupps, P.T. (1959-1977) "Reproduction in Domestic Animals", 1st-3rd Ed., Academic Press, N.Y.C.
47. Hafez, E.S.E. (1962-1980) "Reproduction in Domestic Animals", Lea and Febiger,1st-4th Ed. Philadelphia, PA.
48. Hansel, W. and Wagner, W.C. (1960) Luteal Inhibition in the Bovine as a Result of Oxytocin Injections, Uterine Dilatation and Intrauterine Injections of Seminal and Preputial Fluids, J. Dairy Sci. 43, 6, 798.
49. Morrow, D.A. (1980) "Current Therapy in Theriogenology", W.B. Saunders, Co.. Philadelphia.
50. Hagan, W.A., Bruner, D.W., Gillespie, J.H. and Timoney, J. (1951-1981) "Hagan's Infectious Diseases of Domestic Animals", 1st-7th Ed. Comstock Publ. Co., Ithaca, N.Y.
51. Hansel, W. and Convey, E.M. (1983) Physiology of the Estrous Cycle, J.of An. Sci. 57, Suppl. 2, 404-424 (Diamond Jubilee(75th) Issue)
52. Blood, D.C., Henderson, J.A. & Radostits, O.M. (1960-1980) "Veterinary Medicine", 4 Editions, Williams and Williams, Co., Baltimore, MD.
53. Gall, C. (1981) "Goat Production", Academic Press, N.Y.C.
54. Leman, A.D. (1981) "Diseaes of Swine", 5th Ed. Iowa State University Press, Ames, Iowa.
55. Marsh, H. (1965) "Newsom's Sheep Diseases", 3rd Ed., Willilams Wilkins Co. Baltimore, MD
56. Jensen, R. and Swift, B.L. (1982) "Diseases of Sheep", 2nd Ed. Lea & Febiger Co., Philadelphia, PA.
57. Jubb, K.V.F.and Kennedy, P.C. (1963, 1970,1985) "Pathology of Domestic Animals", 1st 2nd & 3rd Editions. Academic Press, N.Y.C. (with Chapters contributed by K. McEntee on pathology of the male and female genital systems).
58. McDonald, L.E. (1975) "Veterinary Endocrinology and Reproduction", 2nd Ed., Lea and Febiger, Philadelphia, PA.
59. Rossdale, P.D. and Ricketts, S.W. (1980) "Equine Stud Farm Medicine", 2nd Ed., Lea and Febiger, Philadelphia, PA
60. Rowlands, I.W. and Allen, R.W. (1975,1979,1982) 1st, 2nd & 3rd International Symposium on Equine Reproduction, Suppl. Jour. of Reproduction and Fertility, Blackwell Scientific Publications, London.
61. Ginther, O.J. (1979) "Reproductive Biology of the Mare", Cross Plaines, Wisc. 53528.
62. Walker, D.F. and Vaughan, J.T. (1980) "Bovine and Equine Urogenital Surgery", Lea and Febiger, Philadelphia, PA.
63. Sloss, V. and Dufty, J.H. (1980) "Handbook of Bovine Obstetrics", Williams Wilkins Co., Baltimore, MD
64. Society of Theriogenology Manuals: (Association Bldg. 9th and Minesota, Hastings, Nebr. 68901)
    a. Ball, L., Ott, R., Mortimer, R. and Simons, J. - Bull Manual
    b. Johnston, S., Larsen, R. and Olson, P. - Canine Manual
    c. McGee, W., Pierson, R., Ward, J.D., Gloyd, J., Meirs, D. and Witherspoon, D. - Broodmare Manual
    d. Kenney, R.M., Hurtgen, J., Pierson, R., Witherspoon, D. and Simons, J. - Stallion Manual
    e. Hurtgen, J.P. - Boar Manual
    f. Ott, R. and Memon, M.A. - Sheep and Goat Manual.
65. Lein, D.H. (1985) Infertility in the Bitch and Queen in Veterinary Obstetrics and Genital Diseases (Theriogenology) 3rd Ed., Publ. by S.J. Roberts, Woodstock, VT 05091.
66a. Concannon, P.W. (1983) Reproductive Physiology and Endocrine Patterns in the Bitch, Current Veterinary Therapy, VII Small Anim. Practice, Edited by R.W. Kirk, W.B. Saunders Co., Philadelphia, PA.
67b. Concannon, P.W. (1984) Endocrinology of Canine Estrous Cycles, Pregnancy and Parturition, Proc.An. Mtg. Soc. for Theriog. Denver, Colo. 1-24.
68. Osborne, V.E. (1966) An Analysis of the Pattern of Ovulation as it Occurs in the Animal Reproductive Cycle of the Mare in Australia, Austral.Vet. J. 42, 149.
69. Jainudeen, M.R. (1984) Reproduction in the Water Buffalo, 10th Internat. Congr. on Anim. Reprod. and Artif. Insemin., Univ. of Ill., Urbana, Champaign, Vol IV XIV-42.
70. Neely, D.P., Liu, I.K.M. and Hillman, R.B. (1983) "Equine Reproduction", Hoffman-LaRoche Inc., Nutley, NJ 07110.
71. Krook. L. (Editor) (1985) The 75th Anniversary Issue of the Cornell Veterinarian 75, 1.
72. Thuirer, C.B. (1983) Jubilee Issue (75th) J. An. Sci., 57, Suppl.2.
73. Jainudeen, M.R. (1983) The Water Buffalo, Pertanika 6 (Rev. Suppl) 131-151.
74. Asbury, A.C. (1984) Uterine Defense Mechanisms in the Mare: The Use of Intrauterine Plasma in the Management of Endometritis,Theriog. 21, 2, 387-393.
75. Blom,E.(1950) On the Evaluation of Bull Semen with Special Reference to its Employment for Artificial Insemination, Theriog., C.F. Mortensen, Copenhagen.
76. Blom, E. and Christensen, N.O. (1971) A Systematic Search for Abnormalities in Testis-Epididymis in Pedigree Bulls in Denmark, Yearbook, Royal Vet. and Agr. Univ. Copenhagen, Denmark.

77. Elsden, R.P. (1985) Bovine Embryo Transfer - A Veterinary Perspective, 77th Ann. Conf. for Veterinarians, N.Y. State Coll. of Vet. Med., Ithaca, N.Y.
78. Doig, P.A., Ruhnke, H.L. and Miller, R.B. (1984) Bovine Reproduction Failure Associated with Ureaplasma diversum Proc.Ann. Mtg. AABP, 16, 155, Oklahoma City.
79. Allen, R.W. and Antczak, D.F. (1985) Equine Embryo Transfer, Equine Vet. Jour., Suppl. 3, pp 1-114.
80. Cardeilhac, P.T. and Lane, T.J. (1981-1985) Proceedings of First Annual Alligator Production Conferences, Univ. of Florida, Gainesville, FL.
81. Almeida, A.P., Ayalon, A, Faingold,D., Marcus, S. and Lewis, I. (1984) The Relationship between Uterine Environment and Early Embryonic Mortality in Normal and Repeat-Breeder Friesian Cows, Vol III, 438, 10th Internat. Cong. on Anim., Reprod. and Artif. Insemin. Univ. of Ill, Urbana, Champlain.
82. Roberts, S.J. (1972) The Emerging Fabric of Clinical Science in Veterinary Colleges, JAVMA, 160, 6, 853-856.
83. Allen, G.P. and Bryans, J.T. (1985) Molecular Epizootiology, Pathogenesis and Prophylaxis of Equine Herpesvirus-I Infections, Progress in Veterinary Microbiology, R. Pandey and S. Kager, A. G. Basel, Switzerland, (In press).