CSIRO PUBLISHING

Reproduction, Fertility and Development, 2016, **28**, xix–xxi
http://dx.doi.org/10.1071/RDv28n2_PA

Recipient of the 2016 IETS Pioneer Award: Charles Earle Pope, PhD

Earle Pope was born and raised on a small row-crop farm in north-eastern Arkansas. Although the primary cash crops were cotton and soybeans, a few acres were allotted to corn for feeding the livestock during the winter. One of his first chores was pumping water for both the livestock and the house, which did not have electricity or indoor plumbing. In 1966, he received a degree in animal husbandry from Arkansas State College, where he was a member of the livestock judging team and the Block and Bridle Club. During his senior year, his unofficial advisor, a poultry science professor, first proposed the possibility of attending graduate school. Furthermore, he recommended applying to Louisiana State University (his alma mater) and majoring in reproductive physiology. Pope became the first graduate student of Charles K. Vincent, a newly minted assistant professor of animal science at Louisiana State University whose PhD research included the development of a technique for reciprocal embryo transfer in pigs.

In 1968, after obtaining his MS degree, Pope entered graduate school at the University of Missouri as a student in the laboratory of Billy N. Day. Pope's dissertation research was to develop a method for *in vitro* culture of *in vivo*-derived one- and two-cell pig embryos. *In vivo*-viability of embryos transferred to recipient gilts was shown by the birth of piglets after 24 or 48 h in culture (Pope and Day 1977). Pope's first publication was the result of an ancillary project in which it was determined that pig embryos restricted to the ampullar portion of the oviduct were capable of blastocyst development (Pope and Day 1972). In 1972, Pope accepted a joint postdoctoral fellowship between the USDA and Oklahoma State University to participate in a continuing study on hormonal induction of twinning in beef cattle being conducted at the Fort Reno Livestock Research Station, El Reno, Oklahoma, under the direction of E. J. Turman. Pope established a small laboratory in the former tack room of a horse barn adjacent to the pens/pasture where the twinning project cows were located. There he developed a method for *in vitro* maturation of bovine oocytes in modified SOF medium in a reduced O_2 atmosphere and examined the effects of amino acid supplementation and of bovine serum albumin vs fetal bovine serum (Pope and Turman 1974). After completing his postdoctorate, Pope accepted a position at a commercial cow embryo transfer facility in Las Animas, Colorado, owned and operated by his graduate advisor at Louisiana State University, Vincent. Officially, Pope was the staff embryologist, but his other responsibilities included AI technician, monitoring ovarian response to gonadotropin treatment in donors by rectal palpation, oestrous detection and hauling recipient cattle in a 40′ trailer to and from the dry lot located 8 km from the embryo transfer facility.

In 1977, a serendipitous meeting with Lee R. Beck, a faculty member of the Department of Obstetrics and Gynaecology at the University of Alabama in Birmingham resulted in a major change in Pope's career path. Although the primary funding for Beck's research was for the development of controlled-release contraception systems using the baboon as the primate model, Pope's assigned mission was 'do something with baboon embryos.' Beck was also the business partner of the owner of a large Holstein dairy farm near Cincinnati, Ohio, who wanted to establish an intramural embryo transfer program. Thus, from 1978 to 1985, Pope worked with baboon embryos in Alabama while making regular trips to Ohio every 4 to 6 weeks for 2 or 3 days of cow embryo transfer. Also, during the early 1980s, Betsy Dresser was establishing a program at the Cincinnati Zoo to develop assisted reproductive techniques for conservation of endangered species. Her request to use Holstein cows as recipients of common eland (an African antelope) embryos was the beginning of a collaboration that continued until her retirement 30 years later. During the first 3 years, Dresser synchronised eland embryo transfer trials at the zoo to coincide with that of Pope's cow embryo transfer schedule. After 2 days of cow embryo transfer, Pope would spend the following day or two at the zoo doing eland, and bongo, embryo recovery and transfer. The signature accomplishment from that project was the successful transfer of bongo embryos recovered at the Los Angeles Zoo into eland and bongo recipients at the Cincinnati Zoo that resulted in the births of two healthy bongo female calves – one from intra- and one from inter-species transfer.

Meanwhile, in Alabama, Pope, using materials found in one of Beck's laboratories recently vacated by a bioengineer, modified a commercially available uterine cell sampler by adding micro-bore tubing to make a continuous flow device that could be used for transcervical embryo recovery in the baboon (Pope *et al.* 1980). Embryos flushed nonsurgically from the uterus of natural cycling females ranged in development from two cells to blastocysts and were capable of *in vitro* development to post-implantation stages (Pope *et al.* 1982). Live offspring were born after nonsurgical transfer of cryopreserved embryos (Pope *et al.* 1986) and auto-transfer of a four-cell stage embryo immediately after recovery. In 1984–1985, Pope served as the director of the newly established human *in vitro* fertilisation laboratory at the University of Alabama in Birmingham, the first such laboratory in Alabama.

After 5 years of collaborating with Dresser on the bongo/eland embryo transfer project, Pope accepted a full-time position as head of the Animal Conservation Division, Center for Reproduction of Endangered Wildlife, at the Cincinnati Zoo. The hoofed-stock embryo transfer program was soon expanded to include successful interspecies transfer of gaur (*Bos gaurus*) embryos into domestic cow recipients and intra-species transfer of scimitar-horned onyx embryos. While Dresser's laboratory had established methods for superovulation, embryo recovery, and transfer in the domestic cat, Pope realised that having the capability of producing cat embryos *in vitro* was essential for future application to endangered felid species. The birth of an Indian desert cat kitten produced by *in vitro* fertilisation and embryo transfer into a domestic cat recipient was the first successful demonstration of that technology (Pope *et al.* 1993).

From 1990 to 1995, Pope's research was focused primarily on expanding the repertoire of techniques available for producing cat embryos *in vitro* and included studies on embryo cryopreservation and transfer (Pope *et al.* 1994), factors affecting production of embryos from *in vitro* matured oocytes (Pope *et al.* 1997*b*), and micro-assisted fertilisation by intracytoplasmic sperm injection of *in vivo* matured oocytes (Pope *et al.* 1998). Proof of concept was shown by births of live kittens after transfer of embryos derived using the various techniques. In 1995, Pope's work with nonhuman primates resumed when a team from three local human infertility clinics was assembled to do a project on gorilla *in vitro* fertilisation/embryo transfer. A female gorilla infant was born after auto-transfer of three embryos at 48 h after *in vitro* fertilisation (Pope *et al.* 1997*a*).

Pope moved to New Orleans in 1996 to become senior scientist at the newly established Audubon Center for Research of Endangered species (ACRES), with Dresser as the director of research. The expansion in facilities, funds, and access to animals produced two decades of innovative advancements in the development of ARTs, especially for conservation of endangered felids. Pope's collaboration with fellow senior scientist, Martha Gómez, who joined the ACRES staff in 1998, has resulted in over 25 peer-reviewed publications on felid ARTs and includes topics ranging from her postdoctoral studies on cryopreservation and ICSI of *in vitro* matured oocytes (Gómez *et al.* 2000, 2003), to successful application of interspecies somatic cell nuclear transfer in African wildcats (Gómez *et al.* 2004) and sand cats (Gómez *et al.* 2008), and intra-species somatic cell nuclear transfer in the caracal (Gómez *et al.* 2009*b*), and more recently, derivation of embryonic stem cell-like cells (Gómez *et al.* 2010), generation of transgenic cloned kittens (Gómez *et al.* 2009*a*), identification of spermatogonial stem-cells, and derivation of mesenchymal stem cells from two sources of adipose tissue. Pope developed the laparoscopic oviducal embryo transfer procedure, which played a central role in the production of the cloned kittens. The birth of an African wildcat kitten produced by transfer of cryopreserved *in vitro* fertilisation derived embryos into a domestic cat recipient in 1999 (Pope 2000) was followed by the births of *in vitro* fertilisation derived kittens from three additional non-domestic species – caracal kittens following transfer of both fresh and cryopreserved embryos and fishing cat and serval kittens by fresh embryo transfer (Pope *et al.* 2006). Other advancements in felid ART included births of domestic kittens after transfer of embryos derived from oocyte and embryo vitrification (Pope *et al.* 2009), and after transfer of gender-selected embryos derived from *in vitro* fertilisation with flow-sorted sperm (Pope *et al.* 2012*b*). And, most recently, black-footed cat kittens were born after intra- and interspecies transfer of cryopreserved embryos derived by *in vitro* fertilisation with cryopreserved sperm (Pope *et al.* 2012*a*). In addition to felid ART, for 10 years, another major area of research at ACRES was the development of ARTs in eland and bongo antelope. Behavioural training and hydraulic chute restraint allowed handling of eland antelope without general anaesthesia and enabled development of techniques for ultrasound-guided oocyte retrieval in both eland and bongo (Wirtu *et al.* 2009).

Pope has been a regular participant at most IETS meetings since 1975. He served as a member of the Foundation Board of Governors from 2006 to 2013 and on the IETS student research competition committee from 1996 to 1999 and from 2006 to 2013. He has been on the editorial board of *Theriogenology* since 1997. He was an invited co-editor of a special issue of *Theriogenology* on Felid Reproduction (2006) in honour of V. M. Shille. He has been an *ad hoc* reviewer of at least eight other scientific journals. He has been the major advisor for three MS students and three PhD students; in addition, he has served on the advisory committee of a dozen other graduate students and mentored several international scholars who spent periods of 1 month to 1 year doing research in his laboratory. From 2011 to 2015, he was responsible for organising the annual Gulf Coast Conservation Biology Symposium held annually at ACRES, the educational component of a collaborative program between ACRES and Louisiana State University. Pope has published 63 journal articles, 8 book chapters, 30 proceedings, 130 refereed abstracts, and given at least 30 invited presentations at scientific meetings, workshops, and seminars.

Bibliography

Gómez, M. C., Pope, C. E., Harris, R. F., Davis, A., Mikota, S., and Dresser, B. L. (2000). Births of kittens produced by intracytoplasmic sperm injection of domestic cat oocytes matured *in vitro*. *Reprod. Fertil. Dev.* **12**, 423–433. doi:10.1071/RD00126

Gómez, M. C., Pope, C. E., Harris, R., Mikota, S., and Dresser, B. L. (2003). Development of *in vitro* matured, *in vitro* fertilized domestic cat

embryos following cryopreservation, culture and transfer. *Theriogenology* **60**, 239–251. doi:10.1016/S0093-691X(03)00004-9

Gómez, M. C., Pope, C. E., Giraldo, A., Lyons, L. A., Harris, R. F., King, A. L., Cole, A., Godke, R. A., and Dresser, B. L. (2004). Birth of African Wildcat cloned kittens born from domestic cats. *Cloning Stem Cells* **6**, 247–258. doi:10.1089/CLO.2004.6.247

Gómez, M. C., Pope, C. E., Kutner, R. H., Ricks, D. M., Lyons, L. A., Truhe, M., Dumas, C., Lyons, J., López, M., Dresser, B. L., and Reiser, J. (2008). Nuclear transfer of sand cat cells into enucleated domestic cat oocytes is affected by cryopreservation of donor cells. *Cloning Stem Cells* **10**, 469–484. doi:10.1089/CLO.2008.0021

Gómez, M. C., Pope, C. E., Kutner, R. H., Ricks, D. M., Lyons, L. A., Ruhe, M. T., Dumas, C., Lyons, J., Dresser, B. L., and Reiser, J. (2009*a*). Generation of domestic transgenic cloned kittens using lentivirus vectors. *Cloning Stem Cells* **11**, 167–176. doi:10.1089/CLO.2008.0054

Gómez, M. C., Pope, C. E., Ricks, D., Lyons, J., Dumas, C., and Dresser, B. L. (2009*b*). Cloning endangered wild felids by using heterospecific donor oocytes and interspecies embryo transfer. *Reprod. Fertil. Dev.* **21**, 76–82. doi:10.1071/RD08222

Gómez, M. C., Serrano, M. A., Pope, C. E., Jenkins, J. A., Biancardi, M., López, M., Dumas, C., Galiguis, J., and Dresser, B. L. (2010). Derivation of cat embryonic stem-like cells from *in vitro*-produced blastocysts on homologous and heterologous feeder cells. *Theriogenology* **74**, 498–515. doi:10.1016/J.THERIOGENOLOGY.2010.05.023

Pope, C. E. (2000). Embryo technology in conservation efforts for endangered felids. *Theriogenology* **53**, 163–174. doi:10.1016/S0093-691X(99)00249-6

Pope, C. E., and Day, B. N. (1972). Development of pig embryos following restriction to the ampullary portion of the oviduct. *J. Reprod. Fertil.* **31**, 135–138. doi:10.1530/JRF.0.0310135

Pope, C. E., and Day, B. N. (1977). Transfer of preimplantation pig embryos following *in vitro* culture for 24 to 48 hours. *J. Anim. Sci.* **44**, 1036–1040.

Pope, C. E., and Turman, E. J. (1974). Maturation of bovine oocytes *in vitro* and *in vivo*. *J. Anim. Sci.* **39**, 221. [Abstract]

Pope, C. E., Pope, V. Z., and Beck, L. R. (1980). Nonsurgical recovery of uterine embryos in the baboon. *Biol. Reprod.* **23**, 657–662. doi:10.1095/BIOLREPROD23.3.657

Pope, C. E., Pope, V. Z., and Beck, L. R. (1982). Culture of preimplantation baboon embryos to postimplantation stages *in vitro*. *Biol. Reprod.* **27**, 915–923. doi:10.1095/BIOLREPROD27.4.915

Pope, C. E., Pope, V. Z., and Beck, L. R. (1986). Cryopreservation and transfer of baboon embryos. *J. In Vitro Fert. Embryo Transf.* **3**, 33–39. doi:10.1007/BF01131378

Pope, C. E., Keller, G. L., and Dresser, B. L. (1993). *In vitro* fertilization in domestic and nondomestic cats including sequences of early nuclear events, *in vitro* development, cryopreservation and successful intra- and interspecies embryo transfer. *J. Reprod. Fertil. Suppl.* **47**, 189–201.

Pope, C. E., McRae, M. A., Plair, B. L., Keller, G. L., and Dresser, B. L. (1994). Successful *in vitro* and *in vivo* development of *in vitro* fertilized two- to four-cell cat embryos following cryopreservation, culture and transfer. *Theriogenology* **42**, 513–525. doi:10.1016/0093-691X(94)90689-G

Pope, C. E., Dresser, B. L., Chin, N. W., Liu, J. H., Loskutoff, N. M., Behnke, E. J., Brown, C., McRae, M. A., Sinoway, C. E., Campbell, M. K., Cameron, K. N., Owens, O. M., Johnson, C. A., and Cedars, M. I. (1997*a*). Birth of a western lowland gorilla (*Gorilla gorilla gorilla*) following *in vitro* fertilization and embryo transfer. *Am. J. Primatol.* **41**, 247–260. doi:10.1002/(SICI)1098-2345(1997)41:3<247::AID-AJP6>3.0.CO;2-X

Pope, C. E., McRae, M. A., Plair, B. L., Keller, G. L., and Dresser, B. L. (1997*b*). *In vitro* and *in vivo* development of embryos produced by *in vitro* maturation and *in vitro* fertilization of cat oocytes. *J. Reprod. Fertil. Suppl.* **51**, 69–82.

Pope, C. E., Johnson, C. A., McRae, M. A., Keller, G. L., and Dresser, B. L. (1998). Development of embryos produced by intracytoplasmic sperm injection of cat oocytes. *Anim. Reprod. Sci.* **53**, 221–236. doi:10.1016/S0378-4320(98)00115-8

Pope, C. E., Gómez, M. C., and Dresser, B. L. (2006). *In vitro* embryo production in domestic and nondomestic cats. *Theriogenology* **66**, 1518–1524. doi:10.1016/J.THERIOGENOLOGY.2006.01.026

Pope, C. E., Crichton, E. G., Gómez, M. C., Dumas, C., and Dresser, B. L. (2009). Birth of domestic cat kittens of predetermined sex after transfer of embryos produced by *in vitro* fertilization of oocytes with flow sorted sperm. *Theriogenology* **71**, 864–871. doi:10.1016/J.THERIOGENOLOGY.2008.10.012

Pope, C. E., Gómez, M. C., Galiguis, J., and Dresser, B. L. (2012*a*). Applying embryo cryopreservation technologies to the production of domestic and black-footed cats. *Reprod. Domest. Anim.* **47**(Suppl. 6), 125–129. doi:10.1111/RDA.12053

Pope, C. E., Gómez, M. C., Kagawa, N., Kuwayama, M., Leibo, S. P., and Dresser, B. L. (2012*b*). *In vivo* survival of domestic cat oocytes after vitrification, intracytoplasmic sperm injection and embryo transfer. *Theriogenology* **77**, 531–538. doi:10.1016/J.THERIOGENOLOGY.2011.08.028

Wirtu, G., Pope, C. E., Paccamonti, D. L., Godke, R. A., and Dresser, B. L. (2009). Ultrasound-guided retrieval and *in vitro* maturation of eland (*Taurotragus oryx*) and bongo (*Tragelaphus eurycerus isaaci)* antelope oocytes. *Anim. Reprod. Sci.* **111**, 160–172. doi:10.1016/J.ANIREPROSCI.2008.02.017