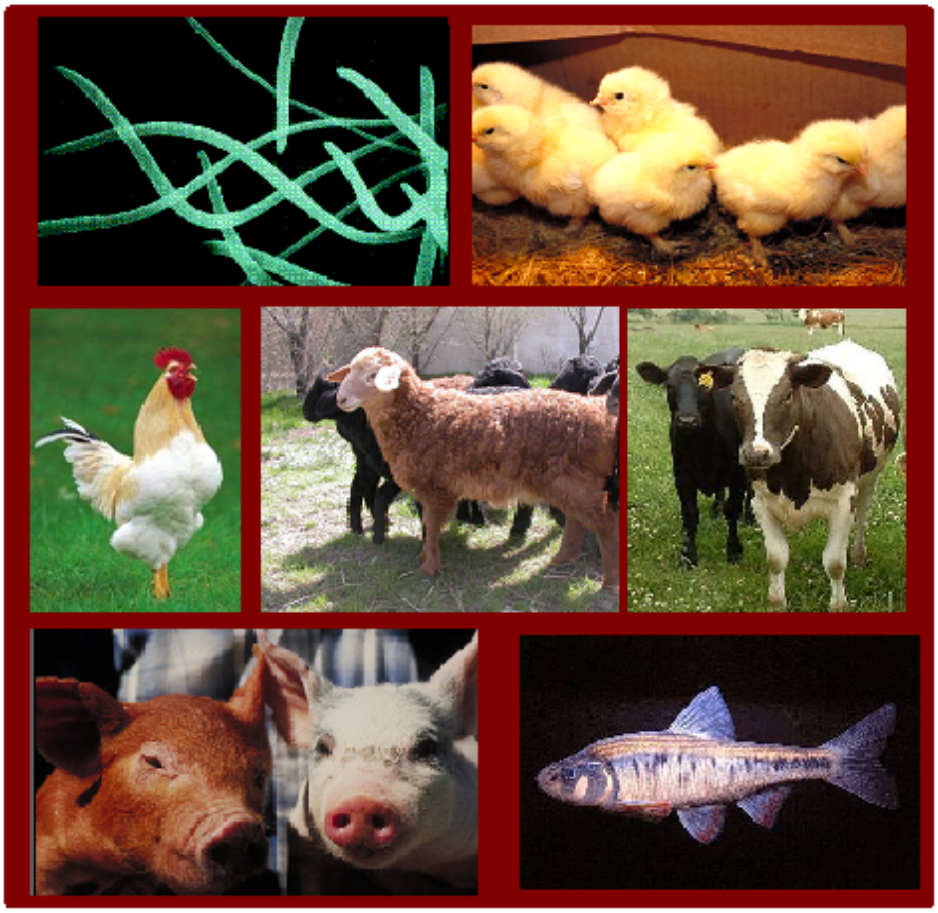
NATIONAL ANIMAL GERMPLASM PROGRAM



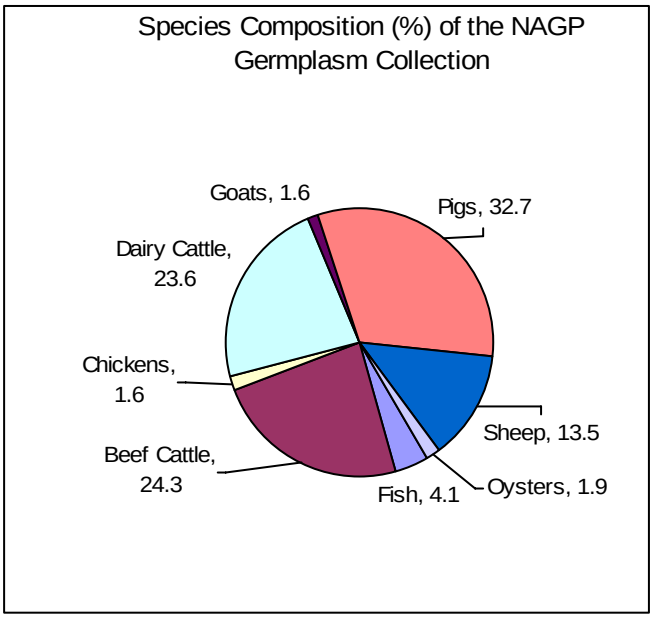
2006 ANNUAL REPORT

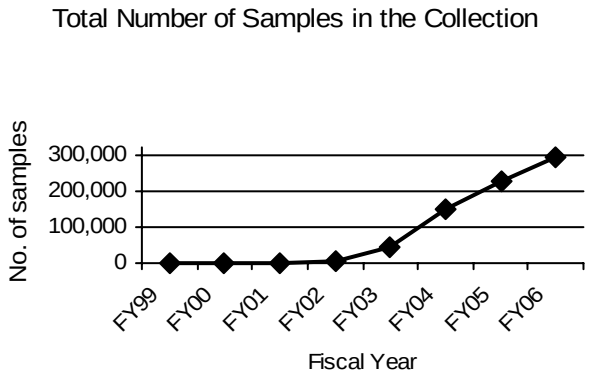
NATIONAL ANIMAL GERMPLASM PROGRAM COLLECTION UPDATE

Problem: Animal genetic resources are the underpinning for profitable livestock production. The genetic resources and genetic diversity can be protected by developing cryopreserved reserves for all economically important livestock species. Without such reserves the livestock industry is at risk from a narrowing genetic base, threat of contagious diseases, and bioterrorism. To address the issue of animal genetic resources, conservation requires three simultaneous actions: building cryopreserves, developing an information system to enhance user understanding of the national collection and breed population dynamics, and understanding the genetic diversity present in livestock populations.

Findings: At the end of fiscal year 2006, the collection contained:

- 129 breeds of cattle, swine, sheep, and goats,
- 82 chicken lines,
- 42 rare breeds,
- 17 aquatic species,
- samples from more than 7,403 different animals, and
- 297,000 samples of semen, blood, and embryos.





Interpretations and Recommendations: Development of cryopreserved germplasm reserves provides a security backup for the U.S. livestock industry and the American consumer. Although the collection has grown significantly during the past year, significant additions at the breed and within breed levels are still needed.

- H. Blackburn
- P. Purdy

UNIQUE ADDITIONS TO THE COLLECTION

Problem: Acquisition of unique genetic material is necessary for the development of a robust collection of animal germplasm. Unique genetic resources are often in remote locations and not available through commercial AI studs. An example of such unique germplasm is the Haumont Shorthorn herd established in the 1930's in Broken Bow, Nebraska. Because the herd was formed before the Shorthorn association split into two associations, one for beef and the other for milk, the animals have continued to be registered in both associations. In addition, this herd has been closed since the 1940's. Germplasm samples from this herd had to be collected on the ranch and transported to NAGP for cryopreservation.

Findings: The Haumont Shorthorn herd represents an important source of unique genetic diversity for the Shorthorn breed since during the last 20 years the breed association has allowed the registration of crossbred Shorthorns. While such a step was necessary for the breed to remain competitive the unique sets of genes that formed the original Shorthorn breed are becoming diminished, making the Haumont Shorthorns even more unique. Sixteen bulls were collected on the ranch in Broken Bow and transported to Fort Collins and cryopreserved. A total of 2,252 units of semen and blood were cryopreserved which more than doubled the Shorthorn collection in the repository. The transported samples had a fresh motility of 76% upon arrival and a post-thaw motility of 34%. Much of the decrease in motility was likely due to the bulls not having undergone a preliminary collection.

Mary Bell Cooksley, owner of Haumont Shorthorns, explains her breeding program and Haumont calves on summer pasture.

Interpretations and Recommendations: The field collection of the Haumont Shorthorns not only increased the size of the NAGP Shorthorn collection but also added unique genetic diversity for that breed. The collection effort also demonstrated NAGP's ability to collect cattle in the field.

- H. Blackburn
- P. Purdy

BUILDING A CORE COLLECTION OF GERMPLASM FOR JERSEY CATTLE

Problem: During the construction of breed collections efforts have been made to sample widely. This process has been aided by the utilization of clustering approaches that use the coefficient of relationship as the measure of genetic distance between the various clusters. Although the clustering approach appears to be functional, we wanted to know if other measures could be used to provide information about how well Core Collection animals represent the breed. To study and quantify this issue we compared the performance characteristics of Jersey cattle in the repository and the U. S. in-situ population. The performance characteristics compared were the predicted transmitting abilities (PTA) for five key traits.

Findings: Pedigree and performance information were obtained from the American Jersey Cattle Association. Based on the computed coefficients of relationship, 22 clusters were formed to represent the entire Jersey breed, of which the collection contained 19 clusters. It was later determined that animals in the missing clusters were of Canadian origin and steps are being taken for the NAGP to acquire samples from those animals. The mean genetic relationships within clusters ranged from 0.05 to 0.36. Eleven of the clusters had mean relationships approaching or exceeding the half-sib level, indicating that the clustering approach is adequately partitioning individuals into like clusters. The table below compares the PTAs for several Jersey traits. For the majority of traits there were no significant differences between the collection and the U. S. in-situ population. A significant difference was found for milk fat, where animals in the collection had a lower mean PTA than the in-situ population.

Comparison of in-situ and Core Collection least squares means for predicted transmitting abilities.

Trait	In-situ (n= 2,817)		Core Collection (n=253)	
	Mean	Std error	Mean	Std error
Fluid Milk, lbs	-635.40	29.69	-615.5	50.13
Milk fat, lbs	- 20.89	1.12	-14.23**	1.90
Milk protein, lbs	- 20.07	0.92	-19.16	1.55
Net merit, $	-130.96	6.77	-122.57	11.40
Jersey Performance Index	- 70.85	3.36	-79.42	5.58

** Least squares means in the same row are different by P<.01.

Interpretations and Recommendations: The statistical analysis indicates that the collection closely mirrors the in-situ population for the performance traits compared. However, there was a significant difference between the NAGP collection and in-situ population for milk fat. Therefore steps will be taken to identify bulls with high milk fat PTAs to add to the NAGP collection.

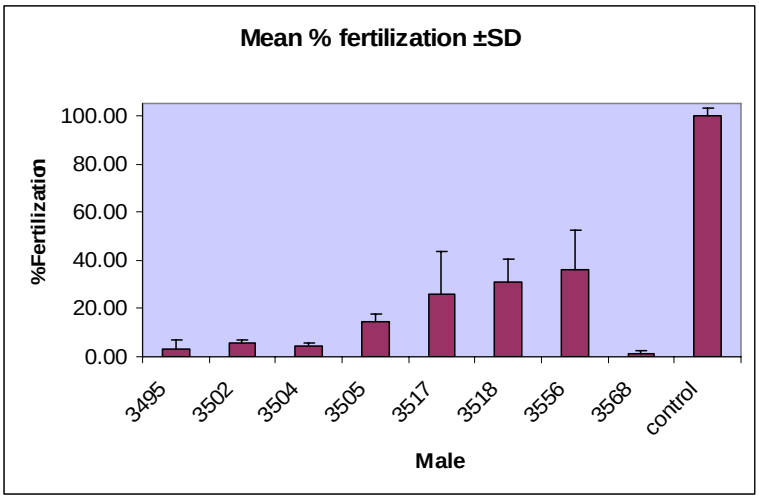
- H. Blackburn

CRYOPRESERVATION OF TROUT LINES

Problem: The ability to effectively cryopreserve trout milt would enable breeders and germplasm repositories to maintain a secure reserve of genetic material from a large number of males for minimal cost for an indefinite amount of time. It will also allow the aquaculture industry to mate fall and spring spawning trout lines. For these potentials to be met fertility levels need to be quantified and cryopreservation protocols established. Therefore, milt from eight trout were shipped from the National Center for Cool and Cold Water Aquaculture (NCCCWA) to NAGP, where the samples were frozen. Later they were shipped back to NCCCWA where each male was used to fertilize 450 (± 35) freshly harvested eggs.

Findings: Individual male fertility, sperm concentration, sperm cell plasma membrane integrity, the ability of sperm to incorporate calcium into the post-thawed cell, and the ability to maintain small amounts of phosphatidylserine on the cell surface were evaluated. The average fertilization rate for the eight males was 18.9%. As can be seen in the figure below significant differences between males existed. Such male to male variation is common for all animal species. It was determined that sperm concentration and plasma membrane integrity were not correlated to fertility. However, calcium incorporation into the cell and phosphatidylserine on the cell surface had significant correlations to fertility (r = .73 and -.72, respectively).

Fertilized trout eggs



Interpretations and Recommendations: These results imply that functional integrity of the sperm (ability to incorporate calcium into the cell) and the membrane status (minimal exposure of phosphatidylserine which is indicative of programmed cell death) may play critical roles in trout sperm physiology and could potentially be used to predict the quality/fertility of a sample.

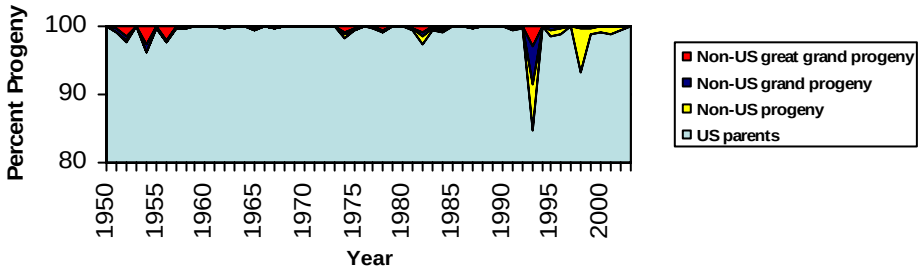
- P. Purdy
- J. Silverstein (NCCCWA)
- H. Blackburn

LONG TERM IMPACT OF IMPORTED GENETICS

Problem: With increasing international discussion about the importation and exportation of animal genetic resources there is a need to evaluate how imported genetics have impacted the livestock industry. This issue was explored by examining the role of newly imported breeds, a breed (Jersey cattle) that has been present in the U.S. since the 1800's, and at the individual animal level.

Findings: Three newly imported breeds were evaluated: Meishan pig (for its prolificacy), Tuli cattle (for adaptability to semi-arid environments), and Boer goat (for increased growth rate and adaptability to semi-arid environments). Of these breeds only the Boer goat has been successful, with the number of Boer registrations in 2000 reaching 45,000 head vs. 150 head for Tuli and none for Meishan. It was concluded that the major elements for successful importation are a clear superiority over existing breeds for several traits, no negative performance characteristics (e.g., slow growth), and sufficient producer interest to promote the newly imported breed. The Boer met all of these criteria; the other two breeds did not. For breeds already in existence in the U.S. newly imported animals must also have superior performance. By tracing the offspring of imported animals for three generations there was not an expansion in the number of third generation progeny (Figure 1), suggesting that no import excelled when compared to U.S.-bred animals. In general, many of the imported animals do not have progeny represented at the grand progeny and great-grand progeny level. At the individual level, animals that are truly genetically superior can impact the U.S. industry as exemplified by the importation of a Yorkshire boar, Ulf, from Sweden which sired 57% more progeny than his nearest U.S. counterpart. On the other hand, the imported Jersey bull with the most progeny sired 87% less progeny than his U.S. bred counterpart.

Figure 1. Percent of non-US progeny, grand progeny, and great-grand progeny Jersey registered by year.



Interpretations and Recommendations: These findings suggest that importing animals (Meishan) for introgression of a single trait is not viable. Furthermore, a successfully imported breed must excel for several traits. Importation of animals for breeds already present in the U.S. can also be problematic if the imported animals are not superior for important production traits.

- H. Blackburn
- D. Gollin (Williams College)

THE FERTILITY OF CRYOPRESERVED RAM SEMEN

Problem: Currently when ram semen samples are collected for inclusion in the NAGP repository they must be shipped overnight to the laboratory for freezing. Holding semen prior to freezing is a practice not commonly performed and consequently the affect on fertility is unknown. Therefore, an experiment was performed to determine the effects of holding ram semen prior to cryopreservation on the resulting fertility. Ram semen was collected, cooled to 5ºC and maintained at this temperature for 24 hours, and then frozen. In a separate treatment ram semen was treated as previously mentioned except the freezing media included cholesterol-loaded cyclodextrin which was added to strengthen the membranes and enable the sperm to survive freezing better. Both of these treatments were compared to the fertility achieved using fresh semen from the same rams.

Findings: Laparoscopic inseminations using fresh semen (control) resulted in 49% fertility and a lambing rate of 1.59. Semen held for 24 hours prior to cryopreservation resulted in 48% fertility and a lambing rate of 1.14 while the cholesterol-loaded-cyclodextrin treatment resulted in 43% fertility and a lambing rate of 1.53. There were no significant differences between the treatments effects for fertility and prolificacy. However, there was an improvement in fertility over last year when our fresh treatment resulted in 36% fertility and lambing rate of 1.20, and our semen treatment held for 24 hours prior to cryopreservation resulted in 26% fertility and a lambing rate of 1.72.

Interpretations and Recommendations: The results demonstrate that reasonable fertility can be achieved using frozen thawed ram semen that has been held at 5ºC for 24 hours prior to cryopreservation. Achieving fertility using semen cryopreserved in this manner is important because it will enable the NAGP to successfully collect samples from around the U.S. and freeze them in the laboratory in Fort Collins. In addition, this information can be used by the sheep industry and potentially increase the utilization of artificial insemination by commercial AI centers and purebred breeders.

- P. Purdy
- H. Blackburn
- R. Stobart (University of Wyoming)

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