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ASSES, MULES AND OTHER EQUINE HYBRIDS

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ASSES MULES AND OTHER EQUINE HYBRIDS

BY

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INTRODUCTION.

Original Purpose.

The work represented in this paper was undertaken with the intent to accomplish ends quite different than those attained. First, it was hoped that here in an industry, immense in its extent and long in its duration, the sole object of which is to produce equine hybrids, would be found a mass of data which could be made to illumine the nature of, and mode of inheritance in mammalian hybrids. In other genera of higher mammals an interspecies cross is announced as an extraordinary accomplishment and the hybrids attentively studied and carefully reported, and it was legitimate to seek in the records of this most common hybrid between two distinct species of higher mammals, material for a more detailed, pains-taking investigation, than had hitherto been made, into the exact nature of hereditary transmission in hybrid forms.

Secondly, there was needed but a glance into the matter to reveal an astonishing discrepancy between the extent and magnitude of this industry of mule breed-

ing, and the amount of care and attention alloted to it. The very word "mule" carries with it for some persons, a stigma of neglect and shiftlessness; in fact those largely and directly engaged in the business are prone to consider mule breeding as outside the pale of scientific improvement. The production of every other class of live stock has been long since investigated and organized, the "right system" has been laid before the farmer, but mule production has not received its share of stimulus. It was hoped, then, that a study of past experience of twenty-five centuries during which mules have been bred, would reveal the "right system" for their production, and that mule breeding could be put on a scientific basis.

Search for Data.

The material useful for the above purposes would be actual breeding records from the books of Jack owners. Almost any kind of data thus recorded carefully and consistently would offer basis for study. The figures might record sex, color, height, or any other measurable factor, of the dam, sire, and foal, but if a series of

any one kind of measurements could be secured the figures, subjected to statistical treatment would reveal what order of hereditary transmission took place.

Record of Jack Breeders. A somewhat extensive canvass of the persons most intimately connected with and heavily interested in the mule breeding industry, with the view to discovering and gaining access to what records of the above nature had accumulated, was planned. The preliminary investigations very soon made it apparent however, that further search in this direction would prove fruitless; indeed the very nature of the business precludes the likely occurrence of such records. The breeders of Jacks and Jennets, though very often without extensive experience in breeding mules, are prominent in the public agitation urging more wide-spread mule production. As might be expected an attempt to secure useful records from this class of breeders failed utterly.

Records from Jack Owners and Mule Breeders. Pedegree, as such, is without value in a mule. The maximum value of a mule is limited by his ability to do work powerfully, quickly, or even gracefully. The most perfect specimen of mule has nothing to recommend him but

this; he possesses no potential power to improve his race. By reason of these facts the thought and attention commonly given to breeding pure-breds or even grades is not applied to mule production; cumulative merit is impossible and there is no direct stimulus to keep records of these cross matings. These facts were made very evident when the owners of Jacks at stud, and the farmers producing mules were interviewed as to their mule breeding records. Valuable information was secured concerning the technique of breeding and raising mules, but of records there were none.

Registry Association. The American Jack and Jennet Registry Association has since 1888 kept breeding records, of a certain nature, pertaining to the production and ancestry lines of asses, but obviously mule records are without their province.

The data found, which is the basis of this treatise has been gleaned from exceedingly various sources as follows.

Farm Periodicals. These publications give very considerable amount of information and discussion of a practical, general, and anecdotal nature, but it is often

biased and without value for scientific purposes.

Scientific Periodicals. Several pieces of work have been done on the anatomical structure of generative organs of mules with a view to explain their sterility. Outside of this field of study, references to mules are incidental and seldom offer new data.

Works. At least three volumes have been published devoted more or less to mules, their characteristics, use, and production. The tenor of two of these volumes is strictly popular and devoted chiefly to their various uses and excellences. The third volume (Tegetmier and Sutherland) bears the marks of scientific accuracy but does not touch the real problem under treatment here.

Works on domestic animals,"Zootechnie", etc. often give valuable information on the question. Correspondence and interviews with breeders and buyers of mules has also been a valuable and fruitful source of material.

Present Purpose.

The facts and conditions described above have made necessary a change in the method and purpose of this

paper. If nothing more than the compilation and arrangement of man's knowledge of mule production is made, something new will have been accomplished.

In order thoroughly to understand the mule a more or less complete knowledge of the ass is necessary; consequently the history and characteristics of the latter are given as well as those of the mule. Certainly the mule breeding industry presents possibilities for improvement but whether the advance must be confined to improvement of mares and asses or to adoption of certain specific breed crosses, must be investigated. Recent hybridization work with corn varieties indicates that a certain hybrid between two varieties may far excel the hybrids between any other two varieties. The problem is to discover if any such breed cross giving extraordinary results, can be found among the equidae.

In order to accumulate data of scientific value Jack owners should be persuaded to adopt a system of record keeping which will contain measurements and descriptions of parents and of off-spring. This could well be done by establishing co-operative recording systems with Jack owners and mule breeders.

PART I.

THE DEVELOPMENT AND PRESENT ECONOMIC SIGNIFICANCE OF THE MULE INDUSTRY.

* * *

CHAPTER I.

The Pre-Historic Development of Asses.

The early history of the horse has been satisfactorily developed by many competent writers. To be sure, the ass has received incidental mention, but this is true only because he is the humble brother of a nobler species, not from any inherent importance which, in the eyes of the historian, he himself has possessed. It is fitting then, that a treatise on mules should give some definite historical information concerning the less popular parent of the mule as well as the chronological development of the hybrid himself.

We will first attempt to discover by an appeal to the "rock records" which of the two equine forms Asinus or the true horse (Caballus) appeared first upon the earth. Paleontologically it is often difficult or even impossible to distinguish between horse and asinine characteristics. Evidence of this nature is never certain, identifications are often based on a few isolated bones, or even a tooth or two, and it should also be recalled that osteological

differences are not at all definite and distinct between these two species even in present day animals.

A study of the literature of the paleoantological development of the horse shows that word to be used broadly, usually including all equine forms. Therefore much of this material throws no light on the relative status of horse and ass forms in those early times. Many of these pre-glacial Equidae are characterized by large heavy heads, short strong limbs, poorly sprung ribs, all suggesting asinine forms, and in cases where all the lumbar vertabrae are not present or the occipital bone is not intact, it would be unsafe to classify unreservedly the animal as a Caballus. In fact it is easily possible that not a few of the osseous remains which form the basis for thought and study in developing the evolutionary history of the horse, are actually from animals resembling more the asinine branch of the Equidae.

The Pleistocene horses of Africa are interesting in that several species of Hipparion are said to exist side by side with forms some of which resemble the true horse (Stenonis) while others show the tooth character of

the zebras.[1] In the same period we find forms closely allied to the African wild ass. According to J. W. Gidley,[2] E. Complicatus of North American Pliestocene, was especially distinguished by its short muzzle, in which respect it resembles the ass. E. Semiplicatus (found in Texas), in certain cranial characters, size and proportion of teeth presents a close relation to the ass, while E. Scotti (also from the Texas fields) is more like E. Burchelli.

The mention of these few specific cases serves to show that the ass is not evolved from the horse, nor vice versa, but that in the early Pleistocene the genus had already bifurcated to form the horse on one side, and the asses and zebras on the other.

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1. H. F. Asborne - The Age of Mammals, p. 431.
2. Quoted by Osborne - Loc. cit. p. 484.

CHAPTER II.

The History of the Ass and Mule as Subjects of Man.

Much evidence goes to show that the ass was the first large quadruped subjugated by man.[1] This was due, probably, in part to its relative abundance in those countries where the earliest civilization arose, and partly to the greater ease with which this animal was captured. To be sure some of the earliest of picture records of Neolithic times represent horses, occasionally as "tamed", i.e. with fixtures on their head or burdens on their backs, but this capture and taming of single animals must not be confused with real domestication where herds are subjugated, controlled and maintained by breeding.

Early Use of the Ass. As early as 3000 B. C. the Syrians were making abundant use of asses but their records show little use of the horse. Also Job had many camels but did not possess a horse, and Abraham with all his wealth does not mention a horse, though he had much cattle, camels and she asses. The Arabs, too, till the first century A. D.

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1. Standard Natural History, Vol. Mam., p. 248.

were restricted to camels and asses as beasts of burden. Lenormant[1] states that asses were used by the ancient Egyptians from the first monumental times while Caballus was not seen till 1900 B. C. Similar quotations and statements could be made at length, which force us to accord to the ass the honor of serving man long and well, centuries before the horse became useful.

Early History of the Mule. The horse as well, was of course kept by some peoples from a very early date, but it did not enjoy as wide a distribution as the ass. The Greeks were among the first to make habitually the cross with the horse, and races between mule drawn chariots were regularly held at the Olympic games. Ridgeway[2] relates that "Anaxilas the despot of Rhegium, won the prize with his mule cart and commemorated it by minting a mule drawn car on his coin". It seems probable that not till the domesticated races of horses and asses had been distributed over the same territory and bred by the same people for several hundred years did mule breeding become common.

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1. Standard Natural History, Vol. Mam., p. 248.
2. Origin of the Thoroughbred Horse, p. 487.

Asses and Mules in America. At various times the early Spanish colonists and explorers abandoned horses in southern North America; all together perhaps as many as fifty to one hundred head were allowed to roam freely. From this stock,which was variously colored, arose the different bands of our western mustangs and bronchos,the enormous numbers of which formed one of the spectacles of pioneer days. An occasional mention of the mule is found in these early accounts, but the first contributions of equine forms probably contained no male asses and quite certainly no she asses. We must look elsewhere for the native burro herds of the west. It seems most likely that the early Spanish missionary expeditions were agent in introducing into this region and scattering widely the parent stock of the western burro.

The first asses on our North Atlantic coast were pre-Revolution importations into Connecticut and Massachusetts of small Jacks of Portugese stock, (importation from Spain was prevented by the Peninsular wars then taking place), to supply mules to the then active West Indian market. These people did not grasp the possibilities of the mule industry and only inferior mares, unfit for any other use, were put

to the Jacks. Satisfactory results could not be expected from such methods; the West Indian trade was soon lost, farmers became discouraged and what might have developed into a thriving industry was given over all together.

Not till General LaFayette in post Revolution times presented to Washington some Andalusian asses, were further importations made. There followed an importation by Henry Clay, of Maltese stock, and thereafter importations became frequent.

At present in practically all parts of the world the production of mules forms a part of the regular agricultural system. Certain regions, notably the province of Poitau, France, and the state of Missouri in our own country, have given special attention to this industry and these sections today produce the most perfect and highest priced mules in the world. Wherever mules have been used in tropical or hot climates their superiority over the horse very soon becomes evident. These points of superiority will be taken up and discussed in detail later.

Terminology.

Before going further it will not be amiss to become acquainted with the terminology used by the breeders and buyers of mules.

The generic name, ass, is seldom used in the trade. A Jack is a male ass; a Jennet is a female, and both names must be used to include the species. Even the official body calls itself The American Breeders' Association of Jacks and Jennets.

Mule, signifies for the trade the off-spring of a mare (Caballus) and a Jack (Asinus). A Jack mule, is the male hybrid, a Jennet mule, the female.

Hinny, is the name given to the produce of the reciprocal cross (Caballus ♂ x Asinus ♀).

Burros are the small unimproved asses formerly occurring in bands and herds in southwestern United States and in Mexico.

Donkey, is a word variously used. It may signify anything from a Catalonian Jack to the meanest plug mule. Most often this word is used to signify smallness. General Shelby of Kentucky contrasts the "diminutive donkey

of three feet to the Jack of Spain".[1]

Mules are classified on the basis of the use they are put to; for example Cotton mules, Sugar mules, Pit mules, etc.

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1. Youatt, The Horse, p. 423.

CHAPTER III.

Natural History of the Ass.

Ancestry of the Modern Domestic Ass. The African wild ass (E. Asinus) is quite generally held to be the source of our common domestic asses, and this species still survives in its primitive wild state in Abyssinia, Nubia, and other parts of northeast Africa lying east of the Nile. It differs from the Asiatic species by being of a grey color instead of a rufus brown and by having, in addition to the dark stripe along the spine, a distinct shoulder stripe reaching from the withers to the fore-leg. Both species have the dorsal band, but the Asiatic lacks the shoulder stripe. Yet the Kiang is said to occasionally have shoulder stripes sometimes double[1] and a specimen of Hemionus has been recorded[2] with distinct shoulder stripes though it properly has none. Darwin reports[3] having heard of three white African asses, not albinos, with no trace of shoulder or spinal stripes, "and I have seen nine other asses with-

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1. Darwin, Animals and Plants, Vol. II, p. 17.
2. Ibid, Origin, p. 199.
3. Ibid, Animals and Plants, Vol. I, p. 64.

out the shoulder stripe, most of them grey". The grey color identifies these latter as Africanus. However, the extreme rarety of such cases does not prevent the use of the shoulder stripe as a diagnostic African ancestry.

However in early times the Asiatic ass was regularly captured and domesticated by peoples native to that country with apparently as good success as ever attended the use of the African species.[1] The people of Hindustan too, who did not possess horses had made the wild ass obedient to the yoke. Arab tribes possessed asses from the dawn of history and there can be little doubt that they were derived from the wild species that inhabitated that region in a similar manner to that in which the wild camels have been domesticated there. Keller[2] says that the Onager, "a much nobler animal, was often captured, bred, and sold by the Asiatics for a higher price than that brought by the African ass" and he considers that this must be considered as a possible additional source of the domestic ass. Keller holds that the ancient Israelites aided very greatly the extension of the African species into west Asia.

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1. Sir A. H. Layard, Nineveh and Its Remains, Vol.II.
2. Naturgeschichte der Haustiere, p. 217.

Dessert Origin of the Ass. At all events whether Asiatic or African, the ass is undubitably desert in origin, Cossar Ewart, after describing the unusual jumping, rearing habits of a wild horse (Prejewalski) which he possesses and whose ancestors were forest horses, speaks of a captive wild ass.[1] "A wild Kiang which I had under observation for a couple of years behaved quite differently. Placed in a paddock he galloped backwards or forwards stopping within a few feet of the fence or pushing against it with his breast but never attempting to clear it". Arabs and Iceland ponies show this same peculiarity, not because they cannot jump, for they may make excellent jumpers when trained but simply because they lack the jumping instinct. Their acquired and inherited habits do not include the act of leaping over obstacles and the "idea" of jumping apparently never enters their head.

The strange and often ridiculous dread that an ass exhibits toward water is additional evidence. Any ass or mule can swim, but a trickling brook is frequently

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1. Trans. High. Soc. 1904, p. 246.

a greater obstacle than a mountain, in the progress of a train of pack burros, so desperate is their prejudice against wet feet. Edward Stewart White says[1] that a "burro can walka round six inch poplar pole,without bark, over whatever may happen to lie beneath it, what this is matters little to him, it may be abyss or torrent", and yet resist with all his strength and wickedness any attempts to force him into a ford. Similarly a burro can live on dry sage brush and stop drinking for days, and can scent water the farthest, after the camel.[2]

The Effects on Asses, of Selection and Improvement. The ass is surely a less plastic form than the true horse. It is difficult to think of the fleet, flat boned, Arab, the coarse flegmatic draught, and the sturdy Shetlands as having a common specific ancestor so diverse are the forms of E. Caballus. Our domestic asses on the other hand have never diverged widely from one another nor even from the parent form. The ass lacking great beauty of form and nobility and dignity of carriage, apparently did not stimulate a desire in the early

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1. Outing, Vol. LI, p. 115.
2. Cowan, Overland Mo., Vol. XLVIII, p.85.

peoples to develope and improve him, and selection has been careless, indifferent, or even neglected all together, with the consequence that many domestic asses are even smaller than their wild parent forms. This deduction in size cannot be accounted for, either, as is sometimes done for the diminutive size of horses in northern countries, by the rigor and severity of the climate, for even in India where natural conditions on the whole are favorable to large growth, asses are so far degraded that they are very often the size of a Newfoundland dog.[1] We are clearly forced to admit that lack of selection, accompanied by malnutrition and hard treatment at the hands of man have brought about actual retrogression in one of nature's wild forms.

The fundamental markings and form of the dessert animal are more or less manifest in his domesticated posterity. There has been a tendency for man to select for deeper colors than the slate grey of the dessert native, and in the longest established breeds of asses, dark colors prevail. In the United States an ass showing

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1. Standard Natural History, Vol. IV, p. 250.

any other color than black except, in the extremities is not eligible to registry. There is yet occasional reversion, even in established breeds of asses to the primaeval coloring and a rudimentary shoulder stripe is frequently present. The feral asses in southern North America have almost completely reverted to the ancestral color pattern.

In body conformation also, neglecting size, the modern domesticated ass approximates the wild African very closely.

Despite this close external likeness, unquestionably the modern ass has degenerated in his psychological characteristics, from his wild free parent. Form and markings have withstood centuries of domestication with fair success but tempermentally the ass has suffered sorely by these years and neglect. It is safe to believe that the fleet, alert, wild ass of the Nubian plains, would refuse all together to confess kinship with the Mexican burros, irresponsive, spiritless, and unbelievably slow and stubborn. However this temperamental transformation had already taken place centuries ago, for as early an narrator as Homer

uses the ass as an epitome of dullness.[1] "And when as an ass passeth along by a cornfield, a lazy ass, whose ribs full many a cudgel hath broken, hath overmastered the boys and maketh his way into the cornfield and croppeth it, while the boys smite him with cudgels and with might and main they drive him forth when he hath his fill of the fodder."

CHAPTER IV.

Numbers and Distribution of Asses and Mules.

The magnitude of the mule industry is little realized by people in the northern half of the United States. A consideration of the enormous money investment in this industry reveals the disproportion which exists

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1. Illiad, XI, 558.

between its importance and the amount of study and attention given it. The number of mules in the United States has been constantly increasing since they were introduced, the industry has never received a check or set-back, such as horses suffered in 1893-5.

Despite this actual progress in both numbers and value there has not lacked for persons to predict its disappearance. No less a person than Professor Nathanial Shaler[1], as recently as 1895, says that "Donkeys belong to a vanishing state of human culture. Now that civilization goes on wheels they seem likely to have an ever decreasing value. A century ago they were in use everywhere, now there are millions of people who know them only by description. They mark a stage that is passing, as did the hand loom and the spinning wheel". A study of the thirteenth census of the United States would reveal facts startling for Professor Shaler.

Rate of Increase. The following table shows the percentage increase for horses and mules from 1890 to 1900.

* * *

1. N. S. Shaler, Domestic Animals.

Percent of Increase of Horses and Mules
From 1890-1900.

Geographical division	Horses	Mules
North Atlantic	5.6	7.2
South Atlantic	12.2	31.5
North Central	5.8	1.3
South Central	29.0	56.2
Western	27.3	46.0
United States	11.1	35.0

For the United States from 1880 to 1890 horses increased nearly twice as fast as mules; 47.3 percent for the former, 24.2 percent for the latter. From 1890 to 1900 mules increased approximately three times as fast as horses. As regards geographic division there is no uniformity of increase shown. In the northern states not only the actual numbers are small but the percentage increase was almost negligible, only about 4 percent for the last decade. In Texas the rate of increase in mules has been phenomenal; from 1890 to 1900 horses increased in that state 14.4 percent, for mules the increase was 113.7 percent. There is but one geographical division,

the North Central which has not shown a greater percentage increase for mules than for horses and the continued and sustained demand is evidenced by the greater value placed on the mules. Per head, all ages, horses are valued at $49.07, mules at $60.17, a difference of over 22 percent in favor of mules. In the northern tier of states mules did not form more than 1 percent of the working animals. In the states just south of these they form from 2 to 6 percent of the work animals. In the remaining states mules compose 11 percent to 62 percent of the work animals. All together these figures remove every possible doubt as to the feeling of American farmers and teamsters toward the mule as a work animal.

Mules are not bred and raised in those states which make largest use of them. This is shown by the disproportionate number of mule colts and mules under two years age in the various regions. 14 percent of all mules in the South Central states are under two years old while in the North Central states 26 percent of all mules found are under two years old. Apparently either southern climate or southern population is unfavorable to the most abundant mule production.

A classification of mules on the basis of the kind of farms on which they are used is interesting. Of all the mules in the United States

33.1 % are used on Cotton Farms
26.9 " " " " Live Stock Farms
20.0 " " " " Hay and Grain Farms
1.3 " " " " Sugar Farms
16.7 " " " " all others and miscellaneous.

More mules are used in cotton production than in any other single industry.

Asses and Burros. The above statements concerning a progressively increasing number of mules in the United States has implied an accompanying increase in asses. We find this increase far exceeds that for mules, being from 1890 to 1900 for the United States 35 percent for the latter, but 94.8 percent for the former.

The average value per head of asses for the United States is $60.92, practically the same as that for mules, $60.17. The former figure however does not fairly represent the asses concerned in mule production. As we have seen, the greatest relative production of mules is carried on in the North Central group of states and here

a per head value of $111.68 is reported. The Western division, including large herds of small burros sometimes worth only a few dollars, reports an average value of only $14.15. It is not at all uncommon in the North Central states for a Jack to bring over $1,000.00 and sales of $5,000.00 occasional.

In Foreign Countries. A study of the proportion of asses and mules in foreign countries reveals an economic status of the ass in those lands, not at all evident in North America.

The American continents alone of all the regions have more mules than asses. In North America the mules are to the asses as 10 : 1. Except in the extreme west region asses are not chosen for work animals as such. Jennets are used for farm work only incidentally, their right to exist, in this country, is to produce breeding stock. In South America mules are to asses as 1.3 : 1. Here the latter are evidently used not alone as breeding animals but also as a beast of burden. When we come to the old world countries we find the ass fulfilling a much more various function. In Spain the number of asses and mules is about equal. In France, Greece, and all Africa,

there are almost two asses for each mule. In Italy and Portugal the proportion is about one mule to three asses. In total Asia the mule is insignificant as a work animal, there being only one of him for each seventy asses. Yet horses are plenty in Asia, there being almost three times as many as there are asses. Asiatics seem either not to be aware of the advantages of the mule, or prejudiced against hybridizing. The ass has maintained his primitive dominence. in Asiatic Turkey mules are not even counted. Asses are two and one half million, horses only about one-third that number.

The table from which the above conclusions are drawn follows.

Table Showing the Numbers of Mules, Asses, and Horses in Various Countries.*

	Mules	Asses	Horses	Ratio of Mules to Asses.
North America	3,980	411	25,596	10 : 1
South America	686	53	5,905	1.3 : 1
France	200	362	3,138	.1 : 1.8
Greece	88	141	159	1 : 1.6
Italy	327	1,000	741	1 : 3
Portugal	59	146	90	1 : 2.6
Germany	---	---		- - --
Russia	---	---		- - --
Spain	767	663		1 : 1.1
Asiatic Turkey	---	2,500	800	- : 1
Total Asia	55	4,000		1 : 7
Africa	280	600	863	1 : 2.2

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* Expressed in Thousands.

PART II.

CHARACTERISTICS OF ASSES AND MULES.

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CHAPTER I.

The Features of the Ass.

It is always easy to distinuish a mule from a horse but the differences between asses and mules, though always manifest, are not so obvious to the casual observer. We will now subject the characteristics of mules to analysis, in order to discover exactly what anatomical peculiarities give to this hybrid his traditional mulish aspect. Externally the mule has chosen the features of his asinine parent in far the greatest degree, therefore an examination of the features of the ass is in order.

The head of the ass is longer and heavier in relation to the body than that of the mule; his bony framework generally is heavier and coarser. The vertrabral column passes from the neck to the sacrem in a nearly straight line, to which is due the lack of grace in the carriage of the head and shoulders. The croup is always shorter and smaller than in horses. The limbs are usually shorter, the joints bigger. The ass's hoof is nearly cylinderical and nearly long, the fetlock is high and the pasterns usually straighter than those of the horse. The ears of the ass have added much to his notoriety,

those of E. A. Africanus always exceeding in length one-half the length of the head,[1] they are usually thick, stiff, and pointed.

The pole, the neck and the withers have but rudimentary hair covering. The upper half of the tail is entirely devoid of long hairs, while those of the lower part are short and not numerous. The body covering of hair is always longer and of colors less varied than of horses.

All zoologists agree that an important zoological trait in Equidae is the condition of the chestnuts. There is in the common horse a callosity on the back and lower surface of each fetlock joint in the center of the tuft of hair which covers that part, and a callosity on each hind leg a little below the true hock joint and immediately over the cuneiform bones. Also there are callosities on the forelegs, inside and just above the knee. The upper callosities, near the knee on the foreleg and the hock on the hind leg are known variously as chestnuts, or castors; the lower callosities under the fetlock as ergots. The chestnuts on all limbs are somewhat oval in

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1. Sanson, Traite de Zootechnie, Tome III, Cap. V.

shape, the fore ones being a little larger than those behind. The ergots are (in Caballus) about one-quarter the size of the chestnut. Some zoologists homologize the four chestnuts with the wrist pads, the ergots to the middle portion of the tri lobed sole pad in the dog and cat. Other men hold that the chestnuts are rudimentary scent glands, similar to those found in some species of deer and other animals. Equs Caballus almost alone of all the family posseses chestnuts on the hinder limbs, and this characteristic has been much used in separating asses and zebras from "true" horses. However, Sanson[1] tells that the hind chestnuts were absent on three horses at Montpellier and rudimentary in two others. He suggests that African horses and ponies often show this trait. Prof. Ewart's Celtic pony, which is surely a Caballus, lacks the hind chestnuts completely.[2] No cases are recorded of pure asses possessing chestnuts on the hinder limbs and it is safe to consider this as a distinguishing biological characteristic.

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1. Sanson, Loc. cit.
2. Smithsonian Rep. 1904, p.443.

The common horse has six lumbar vertrabrae while all asses have but five. This difference is distinct and seldom fails by irregularity. Asses also possess certain peculiarities of dentition which mark them from horses.

The period of gestation for the ass is at least twelve months, for the horse eleven. The ass lacks entirely the "white stockings", and the blaze so common among horses. Piebald asses are very rare, though they do occur.

The ass excels in longivity while a horse seldom reaches twenty-five years of age, asses commonly live till thirty, often over fifty years old.[1]

The "voices" of both ass and horse have each their own distinct and excellent qualities.

With these often very striking and deep-seated dissimilarities between the parents clearly in mind let us consider the condition of these various characteristics in the hybrid off spring, the mule.

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1. Tegetmeir and Sutherland, p. 18.

CHAPTER II.

Features of the Mule.

Naturally it might be expected that the appearance or absence in mules, of certain asinine or equine characteristics would shed some light on the order of hereditary transmission which takes place here, and in a measure this is the case..

It is very obvious that the mule in his general appearance, resembles more the ass than the horse, though probably no single asinine characteristic is constantly transmitted unmodified to the mule. H. Riley says[1] "that it makes little difference how you cross Jacks and mares, the result in 95 percent of the cases is a mule with Jack's legs and feet, the horse's body, the Jack's ears and color marks - and the more like the Jack, the better the mule."

The mule indistry has long furnished the best support to the theory which gives to the sire ability to fix "exterior conformation" and to the dam the greater influence on "interior disposition". There is in truth,

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1. Harvey Riley, The Mule, p.65.

an approximation to this state of affairs in the equine hybrids, although Sanson concludes[1] after carefully considering the circumstances "that this idea appears * * * as a pure illusion of a brilliant imagination." This will be more fully treated under the "hinny".

Certainly the carriage of the body, the quality and development of the hair covering, the nature of the hoof, the long ears and the tendency to "slab-sidedness" give to the mule a very ass-like appearance. The voice of the mule is neither a bray nor a whinney though it resembles more the former. Tempermentally also the mule inherets most largely from the Jack; the hybrid's patience, sagacity, great firmness of purpose, and temerity too, all ass-like characters,are traditional.

The test case as to whether or not the mule inherets the skin of the Jack is the condition of the chestnuts on the hybrid. If this is true they should be absent on the posterior limbs of the mule. Common observation does not show this to be the fact, although Goubaux[2]

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1. Traite etc. Tome II, Cap. II.
2. Quoted by Sanson.

asserts that there is a fixed number of two such appendages among mules. Sanson cites his own extensive experience, and also that of Pagenstecher to show that the number is not fixed, and a little observation makes it clear that there are all possible intermediary conditions of more or less chestnut development between the condition found in the horse and in the ass.

The vertabral number of mules is of interest, in as much as one parent possesses five, the other six, lumbar vertabra. The authorities on anatomy, English or French, are not unanimous on this matter, doubtless because so few mule skeletons have been carefully examined. A collection of the statements on this matter makes it clear that there are hybrid skeletons with distinctly five, distinctly six, or five with a rudimentary sixth. Sanson asserts[1], and probably correctly, that the sixth vertabra behaves in heredity similarly to the posterior chestnuts.

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1. Sanson, Tome II, p. 23.

CHAPTER III.

Hinnies.

Hinnies, though economically not important, are the basis for much discussion and dispute in the literature, and deserve a separate section for treatment. As previously explained they are the off-spring of a female ass (Jennet) and a (Stallion). Opinions regarding them are extremely various due largely to ignorance concerning their exact nature, since the opportunities for observing them are rare.

In only one country are they produced in any great number, namely Sicily. Here they are much used in mine transportation along the steep rocky mountain roads,[1] though it is difficult to assign their abundance here to any cause other than custom and personal preference. In other parts of Europe their production is rare. By virtue of their cheapness asses are often kept by the poorer classes, rather than horses. These are usually small "donkeys" and their hinny off-spring is much more

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1. Sanson, Traite etc., Tome III, p. 6.

valuable than those from a Jack. When hinnies are produced otherwise, in these countries, it is usually by chance or from curiosity. In America they are often produced in considerable numbers in S. W. United States and Mexico. Large burro herds exist here, often on areas which would not support a herd of mares, and the best profits from these herds are got by selling the hinny off-spring.

There is some evidence to show that this is the more difficult coupling to accomplish[1] and that when accomplished the chances for fecundization are less. It is probable, however that this difficulty is largely the result of less practice and less perfected operation on the part of the breeders.

Sanson considers that the hinny furnishes the best evidence against the theory that gives to each sex a specific influence in heredity, certain anatomical regions being controlled by the male, others by the female. Hinnies like mules have a varying number of castors and lumbar vertabrae; their ears, hair, and hoofs, as well

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1. Breeders' Gazette, Aug. 22, 1906, p.327; 1908, Oct. 28, p.807; 1909, Feb. 24, p.455.

as the temperment, are all, as a rule, mulelike. Sanson[1] feels certain that "There are no characteristic differences enabling one to distinguish surely and in all cases a hinny from a mule, the one, as the other, parcipitates in the extremely diverse proportions of its father and its mother."

That the hinny is on an equal economic footing with the mule of like size is shown by the following quotation from a letter by Professor E. A. Trowbridge of the University of Missouri. "Cases are often cited among our students of hinnies and mules which could not be separated without knowing their breeding. In fact only a week ago in one of my classes a boy cited a case in his own town of a man who had shipped in a carload of hinnies and had sold nearly all of them before any one found that they were hinnies, and they had been bought for mules." Many mule dealers are of a belief in harmony with the above.

It is probably true, however, that the equivalence of the hinny and the mule does not exist for minute characteristics and is limited to their economic usefulness. Darwin[2] "cannot doubt that the ass is prepotent over

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1. Sanson, Traite, Tome III, p. 144.
2. Animals and Plants, vol. II, p. 43.

the horse, prepotency in this case running more strongly through the male than the female, so that the mule resembles the ass more closely than does the hinny." He mentions later that the tail of the hinny is more like that of the horse.

Among the most noteworthy opponents of this view of perfect equivalence of the hinny and the mule are Tegetmeir and Sutherland.[1] "The relative influences of male and female are now well known and the distinction between mule and hinny well ascertained." It must be recalled that mules at their best, are not numerous in England, and the poor peasant classes alone, in the British Isles, produce hinnies in any number, giving little opportunity to make observations.

Considering all conflicting evidence and opinions, it seems probable that hinnies, like mules, show little stability or uniformity of type, sometimes resembling more one parent, some times the other, but that in a greater number of cases than a mules they exhibit horse-like traits. Certain it is that both mules and hinnies

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1. Asses, Zebras and Mules, p. 79.

depend on their female parents for their size, and the consequent reduced stature of the hinny is probably the basis of the discrimination (when it exists) against the same.

PART III.

MULE'S POINTS OF SUPERIORITY AS A WORK ANIMAL.

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CHAPTER I.

Endurance.

It has been explained that this paper is an investigation, not an exploitation, of the mule as a work animal. In a discussion under the above head it is easy to "take sides" but the aim here is to subject the superior characteristics which are claimed for the mule by breeders, to scientific scrutiny.

Chief among the excelling traits of the mule is his endurance, to heat, to work, and to rough treatment. It has been stated and it is borne out by all his habits and instincts that the ass is of dessert origin. To this ancestry is probably due in part at least the mule's remarkable resistence to atmospheric heat, which trait alone, would recommend their extensive use in southern countries. To exactly what anatomical peculiarity this resistance is due, is not very clear; their skin is thick and it is not stated that they perspire readily than horses. The fact that they are seldom overcome with heat is doubtless due in a measure to

their "wise forethought" which causes them to keep inside the danger line in their exertions, despite the most arduous pursuasion of their less intuitive driver.

Like asses, mules can exist longer without water to drink than can horses. Army trains in western United States and also in the African Transvaal, when water is short, limit or withdraw it first from the mules, later from the horses. Mules show greater understanding and sagacity, too, when at the trough after strenuous labor in the heat; they drink slowly and sparingly while the horse team mate may greedily take his fill of the coldest water.

It is also asserted that the mule can endure without bad results longer hours of harder and more continuous work than the horse. Certainly this is the opinion commonly held by breeders and users of mules and though it is difficult to account for this fact, it is not safe to deny it. Doubtless it is as much a matter of temperment as of superiority or differences in musculature and organic relations. Mr. James Moffat[1]

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1. Breeders' Gazette, Dec. 21, 1906,, p. 658.

cites several instances where horse team mates of mules doing the same work as the latter, are worn out and replaced "several times over".

Rough treatment a mule can surely withstand at the hands of driver, groom, and feeder, to a degree unequalled by the horse. The mule despite his sagacity and intelligence is with-all more "lumpish", less responsive than the horse. Where the horse becomes desparate the mule becomes stubborn; where the horse is ground and away by abuse, the mule, always hopeless, soaks more profoundly and becomes the unkillable "plug". We have always loved the mule less for his dullness, but a knife not sharp is not easily marred. "As tough as a mule" is good Missouri vernacular; a leathery constitution is theirs; and these traits against bespeak their peculiar suitability to our southern sections where careless, often brutish negro laborers do much of the teaming and tilling.

CHAPTER II.

Economy of Maintenance.

The next great factor which gives to the mule his position of economic importance is economy of maintenance. All persons entitled to an opinion agree that mules do not demand the same fineness and quality in grain and roughage as do horses. Case after case can be found in the farm journals of experiences in support of this fact. Gangs of teams, pairs of teams, or horse and mule team mates are pitted against each other in these journals in respect to the rations they must eat to maintain conditions and vigor. The mules invariably receive a less costly ration than horses, the reduction being due to less amount of, or less valuable, grain fed. It is possible, though doubtful, that the mule as a machine has a greater coefficient of efficiency than the horse, and consequently needs actually less grams of dry matter than the horse to produce a given amount of work. Statements are not uncommon in the journals that a mule needs, "about three to four-fifths as much to eat as a horse". It is also possible, and much more probable, that the mule con-

sumes about the same caloric value of food as the horse, in a less costly form - roughage. When we recall the important role which appetite plays in the nuitrition of animals and the great irregularities in food demands which exists among members of the same species, it is easy to conceive that the mule is constituted so that he can derive his nourishment from coarser, cheaper foods than his equine parent.

The hoof of the mule is harder and grows less rapidly than that of the horse, with the result that a shoe once put on will not loosen, and can be left without danger of the hoof growing over it, till completely worn out. It is generally estimated that the shoeing of mules costs about one half as much as horses.

Greater power for weight than possessed by horses is often claimed for mules. A mule may do more work than a horse of equal size, but it is doubtful if, in forms so similar in their skeletal parts there would be any considerable difference in absolute power per unit weight.

CHAPTER III.

Immunity, Longivity and Intelligence.

Mules show considerable immunity from the common afflictions of the horse. Complete immunity has been claimed for them but this is not the case. They are not exempt, but less liable. According to Riley[1] "The mule that is closest after the Jack is the hardiest; those resembling most the mare are liable to all diseases". The common foot disorders bother mules but little. They are probably just as liable to all these foot troubles[2] and on examination ailments are often unexpectedly found to be present. The mules limbs seem to be less richly supplied with nerves, at least he is not so sensitive in these parts, and will bear much more pain without showing it in lameness, thus enjoying the reputation of freedom from foot disorders.

Longivity. The remarkable longivity of the ass has been mentioned. The mule shows this trait in a pronounced degree; he lives more years and exhibits less

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1. The Mule, p. 31.
2. Ibid, p. 34.

the marks of sinility in his old age. This is not a small factor in raising the value of mules as economical work animals, above that of horses.

Intelligence. Intellectually the mule is a most misunderstood creature. He is to be sure less sportive and less brilliant but he is always more discriminating. Prof. Shaler very properly says[1] "I have never found a person who was equally well acquainted with both animals who hesitated to put the hybrid into an intellectual scale above the horse". Anecdotes exhibiting the great capacity of the mule to learn and to use his learning are without number.

All this boasted intelligence is dissipated, however, by a little water. When fording a stream a mule's reason becomes apparently completely paralized. One will often stop in the middle of the stream and when once embarrassed by the moving sand they lose hope, sink down, and allow themselves to be dragged ashore. Exceedingly muddy roads often have the same effect.

Mules are prized for their sure-footedness and

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1. Domesticated Animals, p. 95.

patience which enables them to pick a way through impossible trails as only a goat can do. They have greater stability, they are less"panicy" and not so likely to shy, as horses. They seldom become wind broken, are truer to start, and have more even draught.

PART IV.

PRODUCTION OF MULES.

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CHAPTER I.

Breeds of Asses.

Despite the relative inelasticity of the asinine species, there have been developed in various more or less isolated regions, varieties with distinct characteristics. In America where all these breeds are used they are permiscuously mixed and their identity lost; to quote from the Jack Stud Book "They simply know a donkey is a donkey and that is the end of it. A detailed anyletical description of these several varieties such as exists for practically all the recognized breeds of live stock is not to be found, and little more than mention of those varieties which have been useful in mule production in this country will be considered here.

Andalusian. In the "person" of "Royal Gift" this was the first recognized breed of asses to enter out country. They are produced in the province of Andalusia, Spain. They are of good form, quality, and size. At present they are not popular in this country since grey is a very common color among them, though the frequent

"off color" among natives indicates that at one time they enjoyed a wide distribution.

Maltese. This is a small, rugged, active animal, with much fineness of bone and form. They have been imported in great numbers into this country and probably today better representatives of this breed can be found here than in the Island of Malta.

Catalonian. The asses from Catalonia in Northern Spain, have proved very popular in this country. The commonest color is a glossy jet black. The hair is smooth, bone is fine and flat, ears very pointed, and they are reported to have "superb action".

Majorca. This is probably the largest breed of asses in existence. The head and ears are enormous, bone is heavy and joints are big, their style is sluggish. No Jennets of this breed have been imported. They have been without great influence in our mule industry.

Poitou. This is the most recent importation. They are the most popular and high priced breed today. They are raised in great numbers in Poitou, France, where mule production has reached a very high state of perfection. They have long hair and do not present a trim

appearance, but produce an excellent grade of mules.

Native. An amalgamation of the breeds above mentioned has resulted from permiscuous mixing and crossing of Jacks and Jennets, and the consequence is a fairly fixed type called the "Native". Most breeders agree that good Native specimens are better than anything that can now be imported and it is doubtful if any foreign breed, with the possible exception of the Poitou can improve the native stock.

Mammoth. The finest, largest asses to day are called "Mammoth Jacks" and are referred to by breeders as the "Mammoth Breed". This "breed" is of American origin and probably represents the most recent improvement of the Native.

Burro. The burro is a distinct breed of itself.[1] Its parent stock was the smaller Spanish asses, and little or no selective improvement has been applied to it.

Up to the present time, in America, the whole tendency has been towards a fusion of these different stocks to form a common type; all asses, except the burro, are included under one breed name "Jacks and Jennets". Show

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1. Breeders' Correspondence.

ring classes provide for "asses", the Maltese competing against the Catalonian. The Stud Book is also published on that basis, though a director in the first volume of the Stud Book appealingly asked "How, in a few generations, can we know the Italian from the Catalonian, if ancestors are not recorded?" Future volumes have not helped to solve the question, and today the mentioned types as such are lost.

Registry Association. In 1888 the "American Breeders' Association of Jacks and Jennets" was established with the following rules of entry.

1. Pedegrees shall give name, color, sex, height, date of birth, name and address of owner, and all the known crosses.

2. All Jacks fourteen and one half hands and all Jennets fourteen hands high shall be elegible to registry if black with white points, up to 1892.

3. The produce of recorded stock shall be elegible to registry any time, filling the requirements of rule No. 2 as to height.

In further rules provision was made to increase, after 1892, the requirements for height to fifteen hands

for Jennets and fifteen and one half hands for Jacks. Also dead ancestry might be recorded without qualifications on payment of one dollar.

It is clear that a very heterogeneous population would be the consequence of this system of registration though at present well bred asses show far greater uniformity than they possessed twenty-five years ago.

Naturally the first few volumes of the Stud Book consist of little more than an enumeration of individual asses, often only name, age and height being given. In the later volume (eight have been published) one is able to trace an animal back to his grand parents or often to his great grand parents.

As mules become more widely used and as the production of all livestock becomes better systematized, there will doubtless come a secondary divergence of type among asses, especially adapted to produce mules for specific purposes. Indeed this development is already indicated by the appearance of the "Mammoth" breed, as an off shoot from the Native.

CHAPTER II.

Market Classes of Mules.

Mules, "having neither pride of ancestry nor hope of posterity" cannot be classified as breeds, yet the trade recognizes several fairly distinct types or market classes.

Miners. These have rugged, compact, short, legs, heavy bones and feet; their principal use is to haul cars of ore or coal to hoisting shafts. Pit mules have the same conformation but are smaller, depending on the height of veins to be worked, geldings are much preferred in this business.

Cotton Mules. These are small mules, lighter boned and not so compactly built as miners. Mare mules sell best in this class. Cotton mules are used chiefly by cotton growers, to plant, till, and harvest the crop, but many are used on city delivery wagons, etc.

Sugar Mules. These are taller, larger, more "breedy" looking, with equal quality and finish but with heavier bone than common mules. These mules often bring the highest price of any class. They are bought in greatest numbers for use on sugar farms.

Draft Mules. These are large, heavy boned, heavy set mules with plenty of quality, that are used for heavy teaming for railroad work, and, the year round, bring the highest prices.

Farm Mules. This is a class of rather mixed mules bought for use on the farms. Many other trade terms are used to indicate mule type, but the above are those employed at the largest mule sales stables.

CHAPTER III.

Types of Mares.

In mule production there are no data whatsoever giving definite information on the effects of any specific matings, and right here is the crox of the problem. Is there a uniform, constant, appreciable, difference in the mules from a shire or a clyde? Do mules from Belgium or Percheron mares bear anything of the breed points of their dams? Is there a cross between specific

breeds of mares and asses which will produce mules of extraordinary merit? It is not inconceivable, that in hybridizing asses and mares, a case of unique interaction of certain specific breeds, producing hybrid off spring of outstanding merit, may appear. Whether or not this is the case can only be determined by accumulating records from mule breeders, which contain information about the type and breed of mare, and Jacks, also the nature and value of the mule produced. This is a task that will demand no small amount of effort and time, and even at best can only be imperfectly accomplished. It is perfectly clear that a man possessing a registered Percheron or Thorough-bred valued at $500.00 cannot afford to produce a mule from her when a pure-bred foal would be worth twice as much. Thus the dams of even the best mules will always be mares of mixed breeding.

All that can be said at present is that good mares will produce good mules. There is but little deliberate effort to produce mules of any specific height. When a farmer decides to breed for mules he does not debate what type he shall produce, but takes his good grade mares to

the biggest smoothest Jack he can find: whatever the mule turns out to be he will find ready sale for it. The question of the predominant breed type in the mare used has little significance for the farmer or the mule buyer.

CHAPTER IV.

Technique of Breeding Mules.

When a hybrid between two species is desired the condition for its creation is not fulfilled by merely securing specimens of opposite sexes of the species to be crossed; natured has fortified herself well against such an abnormal occurrence. In plant forms we have a relatively direct and easy control of the generative process; the first steps, transferring the pollen,(male "substance") from one individual to the pistil (female organ) of another, is a simple mechanical operation, and

we need only safeguard the pistil bearing flowing from any other foreign pollen to complete this stage. This done, however, we have no assurance that the development of the ovule will take place. In many cases the pollen is physiologically incapable to produce any effect. In other cases the ovule develops abundant pulp (somatic tissue) without any plant germ, or yet again, normal seed may be produced and a plant with a new combination of characters is the result.

In many animal forms, especially among insects, nature has endowed the creatures with a"lock and key" arrangement of the generative organs, thus making inter-species crosses mechanically impossible, while she has provided a barrier against intercrossing among the "higher animals", in the shape of a psychic antipathy between the various forms, especially marked in respect to sexual relations.

Though mules are so common among us that we sometimes forget their unnatural origin and the abnormalities of their character, all the evidence goes to show that a "truly wild" mule,could never be created, without some almost inconceivable conditions should come to pass. So

pronounced is the "race prejudice" among both horses and asses, so apparently revolting is the idea (if we may call the conception of an ass by that name) of copulation with another species, that man has been forced to resort to deception and strategy to bring this mating about. Those naturalists who even at the present time interpret the existence of E. Prejvalsky on the basis of an "accidental" cross between two other species would do well to familiarize themselves with actual mule breeding operations. Even the different bands of half wild horses in refuse to intermix in any way.[1]

Behavior of the Mare. Sometimes in the height of oestrum the mare seems to offer little resistance to the advances of the male. However, to insure protection for the Jack from any chance kicks the mare may deliver, a pit is usually dug, in which the mare's hind legs are placed, curtailing their use as weapons; the pit also enables a small Jack to mount a mare of any size. Many mares, on the other hand, will take no more notice of the most arduous Jack than of a bull or a

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1. Ridgeway, Origin of the Thorough-bred Horse, p.35.

buck sheep, and when they do heed him it may be with violence. With such mares tact is necessary. Results are got by using a stallion of her own kind as a "teaser". The mare is humored and "prepared" by the horse; the Jack being previously concealed. At the critical moment the Jack is quickly brought up and substituted for the horse while the mare is not yet fully aware of the change. With these precautions a mare may even yet refuse to accept the Jack, but fecundation with the despised spermatazoa can yet be accomplished by means of the impregnator.

Behavior of Jack. The Jack as nature produces him shows no more eagerness than does the mare for this abnormal mating. Two kinds of jacks are raised, "mule Jacks", and "Jennet Jacks". They are different only in respect to their treatment after birth. Foals intended for Jennet Jacks are allowed to suckle their dams, and to run with the Jennet herd. When mature these Jacks cannot in any manner be prevailed upon to serve a mare. When a mule Jack is desired, the young foal is taken from his mother and put to suckle a mare, and during his colthood should be allowed to run with mares and horses; the less he has of assinine company the better.

Similar measures but opposite must be taken when a colt is raised to breed hinnies. The Jennet is the more unyielding mother and is more averse to allowing the colt to suckle her than is the mare to the little ass. Great tact is needed, however, to make the exchange, with both mothers. A Jack that is raised in the above mentioned manner will be divorced from his natural mate so completely that he will not take to a Jennet when he runs into one by chance.

Strangely enough the affections alienated from the female ass are not transferred in toto to the mare, for but few Jacks effectively do their own "teasing"; in fact a feeling exists among Jack owners that a Jack which does his own teasing is not a sure foal getter.

Jennets and mares also may in a similar manner be taught to form preferences for either Jacks or stallions. Conlin Cameron of Prima County, Arizona,[1] maintains a range herd of burro Jennets and also a herd of mares. In these herds, both Jacks and stallions are allowed to run. Mr. Cameron has noticed that a Jennet which once

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1. Breeders' Gazette, 1909, March 31, p. 785.

breeds to a horse will always do so, and that a mare which produced a mule will always produce a mule, when open to both Jacks and stallions. These strange and abnormal attachments formed by members of one species for those of another, on casual inspection seems to refute the theory that explains the origin and perpetuation of species by preferential matings of slightly different body form, etc. When we recollect, however, under what abnormal stimulae the attractions were originally created this difficulty is removed.

The horse x Zebra cross is no less difficult to bring about. When Ewart came into possession of his Burchell zebra stallion,[1] all previous efforts to effect a coupling with a mare had failed, and for a time Ewart was unable to accomplish it. He says it was only by a most careful study of the minute habits of both the mares and the zebra that he gained his end. However, minute directions are given by Varro, Pliny and Columella as to how to bring about this illicit marriage. They tell of devices to make a mare accept the young ass colt and

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1. Pennycuik Experiments.

and describe in detail the teasing, coupling, etc.[1] but De le Malle also states that in the time of the Romans the common mule was produced with much more difficulty than at the present day.[2] Carl Hagenbeck finds that crosses between Asiatic and African asses are made more readily and the experience of the United States Department of Animal Industry to be cited later, also supports this idea.

Management After Conception. Conception once affected no further difficulties arise, the foetus developing in a perfectly normal manner. A mare carried a mule colt two or three weeks longer than a colt of pure breeding which is to be expected when we recall the normal period of pregnancy for asses is at least twelve months, while for horses it is only eleven. The female ass carries the hinny colt about an equal length of time. Mule foals, at birth, are, if different at all, more lively and hardy than the foals of horses. In this respect the actions of zebra hybrid foals are interesting, for these little creatures, almost immediately after birth, are up and away

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1. Dureau de le Malle, Ann. d Sci. Nat. XXI, 1830, p.60.
2. Loc. cit. p. 85.

almost before their mare mother is again herself. An account of Ewart's "Matapo" will be given later. There are no data, however, to show the relative mortality between mule and horse colts. The growing and feeding of mule colts is a problem outside the sphere of this paper. Suffice it to say, as a general practice they receive less feed and care than do horse colts (unquestionably to their detriment) and are very often broken to work at two years old, thus increasing their period of utility at both ends of life.

PART V.

PROCREATION AMONG MULES.

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CHAPTER I.

General Statements.

About the question of possible fertility in mules there centers a sometimes bitter, sometimes amusing, dispute. Abundant data (of a certain nature) exists to "prove" that mules occasionally exhibit generative powers. Difference of opinion on this matter is not confined to breeders and travellers, either, for "authorities" on the mule breeding industry support opposite sides on the question.

The most firm believer in and eminent supporter of occasional fecundity among mules is the French zoologist Andre Sanson, who uncompromisingly maintains the fertility of female mules. He says[1] "It does not seem inadmissible that the male of the same origin as the females which show themselves so easily fertile, would not themselves behave similarly," and again[2] "if there are fertile males, as we are sure at present that there are fertile females * * *".

France also furnishes us reliable evidence of

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1. Traite de Zootechnie, p. 146.
2. Ibidem, p. 147.

Ayerault[1] says "In Poitou where 50,000 mares are annually used for mule production, fertile mules are unknown, although apart from the temperature, they are in the best possible condition to be fecundated, since they are constantly in contact in the pastures with young horse colts which often copulate with them," and he further unhesitatingly asserts that all cases of supposed fertility are errors in observation or recording. Between these two extremes of opinion are found others of all stages of belief or disbelief. N. S. Shaler[2] comments on the "singular fact" that in only two or three cases have mules become fecund and Tegetmeir speaks guardedly on the matter and urges caution in opinionating. Cossar Ewart[3] admits that certain anatomical data which he possesses seems to suggest that occasional fertility among female mules is not inconceivable.

Practically all the above comment pertains to female mules. No specific case indicating the fertility of the male mule seems to be on record. To be sure

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1. De l'Industrie Mulassiere, p. 152.
2. Domesticated animals, p. 95.
3. Pennycuick Experiments 1899.

Sanson says that"although we do not posses as yet, but observations of relative fertility among the females, it does not seem inadmissable that the males * * * would behave similarly", but at that time (1888) the anatomical evidence extant today was not available. Ewart considers it "safe to say that * * * male mule germ cells are of no use" and Iwanoff[1] states that "the infertility of the male mule is well known as a doubtless fact.

CHAPTER II.

"Explanation"of Supposed Cases.

Those unwilling to give credence to the stories of fertile mules, interpret them in one of two ways. The typical case will present a female (apparently a

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1. Biol. Centbl. 1905.

mule) which has given birth (apparently) to an (apparently) hybrid colt.

1st. The female may have produced a hybrid colt but the real nature of the fertile female may not be known. Frequently horses of mixed breeding are seen which exhibit asinine traits of character, both externally and in disposition. If a female of this nature became pregnant, she might well be mistaken for a fertile mule.

To believers in Telogony these cases offer little difficulty. Tegetmeir quotes Captain Hayes "a practical authority" as saying that "those animals which have been mistaken by superficial observers as fertile mules, are really in most cases off spring of mares that have previously been bred to donkeys, and have given to their foals characteristics of their former lovers."

2nd. The female in question may be a true mule but the foal which she suckles was not born by her. This brings up for consideration the phenomenon of lactation among female mules. Concerning this phase of the question there is little or no debate. Any one long in a

mule country will have experienced cases of true lactation in mules. This is not so remarkable as it might at first appear to be, when we consider the lack of direct physiological connection between the mammery glands and the sex organs. To be sure the mammery tissue is normally activated by conception, cell proliferation in those regions commencing, in smaller forms, almost immediately after copulation, but the exact nature of this relation is not understood. On the other hand every cattle breeder has seen lactation induced in young virgin haefers by constant suckling of a "poorly weaned" calf, and cases are not uncommon where the mammery glands have failed to function even after normal delivery of young. It is not difficult to suppose for the few cases demanding it a set of circumstances which would enable a female mule with maternal characteristics to develope active milk secretion at a time opportune for seducing and fostering a foal born by a mare - perhaps lacking maternal instincts. In herds of horses and mules it might easily happen that a milking mule should adopt an orphan colt and give every appearance of being the

colt's true mother.

Stories accompanied by statements of eye witnesses of the birth, and affidavits of the true hybrid nature of the mother present obvious difficulties to those who would summarily set aside the whole matter of fecund mules as a thing of myth and anecdote, and though we refuse to accept Sanson's declarations we may well maintain an attitude of suspended judgment, or as M. Sanson so characteristically puts it "the attentive study of the conditions in which these observations were produced enlightened by our actual knowledge of the zoology of the equines, demands that we be conservative on the matter".

CHAPTER III.

Anatomical Considerations.

It is impossible definitely to state a workable rule by which one is able to predict the conditions

of fecundity in any given hybrid form; often when least expected, a condition of sterility will appear, or again when there is every reason to expect an infertile hybrid, it may prove capable of generation. Indeed a condition of hybridity is not required to present difficulties in this respect; sterility may occur with no apparent change in the organization. An example is the behavior of many wild animals when confined: though they are given abundant food, water, and exercise, they fail to breed - are virtually sterile. Or certain animals may be sterile for certain matings and fertile for others. Or again, a change of food, a sudden shock may cause a previously sterile animal to recover her fertility. "Of all the organic systems the reproductive system is the most sensitive to changes in surroundings"(Pennycuick).

An attempt to discover the exact anatomical causes of sterility would consist in a histological study of the reproductive glands and their secretions. Such studies have been made on several animal hybrids. In the case of fowl hybrids many observers have discovered that infertility is due to either imperfectly developed seminiferous tubules, "sex glands", in entire lack of spermata-

zoa, or in a degenerate condition of the hereditary elements.[1]

Histology of the Male Organs. Ewart (loc.cit.) examined the seminal fluid of his young zebra hybrid Romulus. He reports finding spermatazoa "incompletely formed. There is a head but the merest rudiment of a tail." Ewart also examined the seminal fluid of a three year old zebra x ass hybrid with similar results. "The germ cells were hardly at all motile due to the tail being only about twice as long as the head, while in the normal horse and zebra it is fully ten times the length of the head." This seems like a case of arrested development.

Iwanoff (loc.cit.) has done much detailed and careful work on the histology of sex organs and secretions of hybrids. The zebroid "Taun" was used for one test. His sex instinct was strong and mounting energetic; several c.c. of normally discharged seminal fluid was collected from the mare. An examination showed a complete lack of germ cells, many round, hard, glasslike

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1. Van E. Iwanoff "Untersuchungen uber Unfruchtbarkeit von Zebroiden", Biol. Centbl. Band XXV, s. 789.

bodies, besides flat epithelial cells and leucocytes were present. Macroscopically the fluid could not be distinguished from that of a horse or a zebra. A zebroid "Menileck" was examined - same conditions as before - the same glancing, refractory bodies present.

He made several examinations of the zebroids at different times and concludes that "one cannot speak of degenerate or undeveloped sperm cells. Probably Ewart mistook the round glasslike bodies with Brownian movement for sperm cells". He confesses an inability to explain the observation of a tail twice the length of a head in the semen of Ewart's mule, and cites his further work and that of Stephan to show that Ewart was wrong in this respect. Stephan[1] holds first place on histological work on mule testes. He finds the "most noticeable difference is the entire absence of semeniferous tubeules". The grouping of interstitial cells was also abnormal. Suchtet, as the result of his work on mule testes concludes that the spermatizoids were replaced by "little round brilliant glassy bodies".[2]

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1. Loc. Cit.
2. Des Hybrids a l'Etat Sauvage, Tome I, p. 62.

Whitehead[1] gives work on testes structure in mules. He found no secondary spermatocytes and no spermatazoa of any kind; inspecial cells were abundant and granular. Whitehead had examined the testes of cryptorchid horses and finds a similar condition. He puts the scrotal testes of mules in the same category with abdominal testes in cryptorchids of pure species. Sexual passion is quite apart from sexual fruitfulness, mules and cryptorchids exhibiting the former in marked degree. Whitehead says that sexual passion is due to specific internal secretions of the interstitial cells. "They are the only cells which can elaborate it for the only other secretory cells are degenerate, while the interstitial cells are hypertrophied".

Female Organs. The femals generative organs have not been so frequently examined. Ewart examined those of a zebra-horse hybrid of ten years of age which had died. He found Graffonian follicles present, one of them being one and one-fourth inches in diameter. A ripe

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1. Whitehead, R. H., "Function of Interspecial cells of Testes". Anatomical Record, Vol. II, p. 177.

follicle in a sixteen hand mare is about one and three quarters inches in diameter. "In the appearance of this follicle it might well have contained an almost ripe ovum". This case has encouraged Professor Ewart to say that "occasional fertility among female mules is not inconceivable". Habenstreit[1] worked on the ovaries of a femule mule and found follicles but no ova. Female mules exhibit regular periods of oestrum but the exact seat of this emotion is not clear.

PART VI.

SEX OF MULES.

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Sex of Animal Hybrids.

The matter of sex in the equine hybrid commonly known as the mule has received somewhat of attention, the interest being stimulated, no doubt, by the mere fact that the animal is a hybrid. The numerical proportion of sexes has scientific significance and there is also commercial discrimination between them.

The hypothesis is propounded that nature abhors a crossing of natural species; that to provide against their increase and spread she causes sterility; that, should this fail and, as an additional inhibitor, she brings many males and few females from the cross. It is asserted that nature frequently resorts to this inequality in sex proportion to accelerate or retard the numerical increase in living forms. Thus if food supply is short and conditions of life are hard males predominate, if everything combines to make life easy, or to demand great numbers, females are born more often than males.

These propositions do not lack supporting evidence. Guyer[1] found, working on museum specimens of hybrid birds,

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1. Biol. Bul. Vol. XVI, p. 197.

among fifty-one cases where sex was known, only four females. Buffon's data coroborates this. Guyer gives as follows the results of Buffon's work which he has collected.

Cross	Males	Females
Goat x Ewe	7	2
Dog x Wolf	3	1
Goldfinch x Canary	16	3
Suchetet's Bird Hybrids	53	15

Buffon also states that in Poitou, where mules are abundant males show a marked preponderance. Guyer harmonizes these data with the theory of sex determination by limiting nourishment, for he assumes there must be considerable disturbance of foetal growth when two radically different germ classes come together. This default in metabolisis, due to these incompatabilities of the germ plasm, causes maleness, and the more dissimilar are the species crossed the greater is the proportion of males.

Sex of Mules.

The experience related by many Jack owners and mule breeders point to this same inequality of sexes. Tegetmier

and Sutherland quote from an unpublished manuscript from Col. Hamilton Smith in which the latter states that three male mules are born to one female, and T. J. Wörder, of Springfield, Ohio, says[1] "In mules general characteristics are asinine and males are two to three times as numerous as females."

Notwithstanding the above statements about mules, and whatever may be the sex proportions among other hybrids, the most trustworthy evidence indicates an equality in the number of male and female mules. General impressions of Jack owners and experiences related from memory of breeders are unsafe bases on which to base conclusions. It will be seen that the trade discriminates against male mules, females finding a readier sale and higher price than males. This leaves farmers to suspect that most of their mules are males; the psychological state of mind being similar to that which causes dairy farmers, who wish many heifer calves, to assert that most calves dropped are bulls. Moreover, those who have given the

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1. An. Rep. Dept. Agr. 1863, p. 180.

matter most careful attention do not find any inequality in the sexes of mules, Sanson, Tegetmier and Sutherland all agree that the proportion of the sexes is one to one when large enough numbers are considered. Many scientific workers at United States Experiment Stations have failed to find any evidence of a disproportion between the sexes in mules.

The Trades Discrimination.

The relative commercial value of the sexes is affected by the community in which they are sold and the uses to which they are to be put, though as a general thing females are more highly esteemed. Riley speaks uncompromisingly in favor of female mules. He says they are superior in every way, much safer and less stubborn than those of the other sex. He holds that the fact that the female is in possession of all her natural faculties while the male is deprived of his by altering explains the difference, "I would give $15.00 more for a mare mule than for a horse mule". F. J. Douglas[1] sums up the matter. "In this warm depressing climate

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1. Breeders' Gazette 1911, p. 353.

(La.) there is a decided preference for mare over Jack mules. Mare mules carry a better shape than Jacks and as a rule are faster workers, more snappy and not so stubborn. Unsex a mule and you take away what little snap and ginger he has; he becomes slow, stubborn and contrary. Mare mules are less liable to screw worms and maggots, which very often attack males about the sheath, causing much irritation and trouble. This also makes a difference in the preference." When mules are shipped females bring higher prices than males because of the less risk which is supposed to be attached to them on a sea voyage.

In Spain and in France a traditional prejudice exists, which augments the preference for femals. Etiquette at the ancient court,[1] made it improper to hitch to the pontificial carriage any mutilated animal. Uncastrated, the male mule would be unmanagable, so the prejudice grew up in favor of males. Later the Spanish nobles, acting on precedence, hitched only females to their great conveyances, and then the common people

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1. Sanson, Tome III, p. 10.

adopted the discrimination against the male.

A male mule is almost never allowed to come to maturity without being castrated.[1] Stud mules are disagreeable and unmanagable - almost useless. They rarely get fat, are always fretting and it is next to impossible to keep them from breaking through anything, anywhere, to get at females. Even when castrated before they pass the yearling form they make "trouble enough" in the feed lot.

PART VII.

OTHER EQUINE HYBRIDS.

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The Promise of New Hybrids.

Since the term mule, strictly translated from the Latin, signifies hybrid it is apparent that there are as many different kinds of mules theoretically possible as there are possible combinations of the ten or twelve equine species. The obvious supposition is, however, that that product most useful to man should be the mule between the two species most commonly used by him at present. But the obvious explanation is not always the right one, and many persons have claimed for mules between other species greater economic value than possessed even by the Caballus x Asinus cross.

Two factors doubtless led to the domestication of Asinus in preference to any other related species; its relative ducility for lack of fight, and its presence in greatest numbers where it was needed. Speed, beauty, alertness, and utility, were not considerations in the selection of this species for domestication and it is very probable that the two species now used are not the only ones fitted mentally and physically to enter into relations with man.[1] It is not strange

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1. Fowler and Lydekker, Mammals Living and Extinct, p.383.

then that certain other branches of the equus genus, in early times either unavailable or untamable by the then existing means, should now offer promise of economic usefulness. Many of these possible crosses have already been accepted.

Hybrids with Caballus.

First let us consider the hybrid Equidae in which Caballus (common horse) forms one parent. The cross between Caballus and Asinus is of course our common mule. As a consequence of the great diversity of type among Asinus there is no specific form for this hybrid. His characteristics have been given.

Asiatic. A horse has been repeatedly crossed with the Asiatic ass (Hemionus), the hybrids being very mule-like in appearance without shoulder stripes but with dorsal stripes feebly developed. The Asiatic ass never approximates the size of our large domesticated asses but otherwise bears great resemblance to Asinus. Obviously there is not much reason to expect greater utility from this hybrid than from our common mule.

Quagga. In Col. Smith's unpublished volume[1] he gives a portrait drawn by himself of a hybrid between the quagga and a pure bred mare. Some faint stripes on the fore quarters were evident. From the existing descriptions of the quagga we are led to believe that this animal possessed attributes allowing it to become a most useful domestic quadruped and it is cause for much regret that the animal is now practically extinct. The quagga was very horselike in character; its quarters were well developed, its tail fairly covered with hair, crest high, ears short, and with all extremely tractible and docile. It was not profusely striped having the zebra pattern distinct over the anterior part of the body but fading away behind the shoulder. It formerly existed in immense herds in Cape Colony and Orange Free State, but despite its eminent suitability as a beast of burden for the inhabitants of the country to which it was native, it has suffered the fate of our own bison, being shot down by the hundreds of thousands for its hide.

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1. Tegetmier and Sutherland, Asses, Zebras and Mules, p. 69.

Zebra. The present congener of the quagga is the more profusely striped zebra of Burchell. This animal infallably arouses enthusiasm in travelers and natural historians; a"lovely animal", "beautiful creature" "facinating specimen" are typical epithets. Unquestionably this is the most horselike of all the asses and zebras now existing in any numbers and has naturally been the subject of much speculation and some experimentation. It has been repeatedly domesticated, broken to both saddle and harness. Many zebra teams are at present in daily use in South Africa and they are reported swift, courageous, persistent, easy mouthed and tractible. One factor especially favors their use in preference to all other equine forms, namely their immunity from the stetse fly bite - the cause of immense losses in horse flesh in Africa.

The hybrid got by crossing Burchellii on Caballus gives great promise of general utility, and is probably better adapted to uses of man than any other hybrid.[1]

Cossar Ewart has given us an interesting account

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1. Tegetmier and Sutherland, p. 65-70.

of the birth of his zebra hybrid "Romulus". Romulus was got by the Burchell zebra stallion "Matapo". Matapo's keepers had previously failed to couple him with anything but zebras, but by carefully studying the habits of the male and female zebra the coupling was finally accomplished with a West Highland pont mare. Pregnancy was for one hundred and forty days, and the birth was normal. "The minute after birth the hybrid was rushing about as if he was a young zebra whose existence depended on his at once joining the troup of which his dam was a member. Being extremely alert and ready to gallop off at any moment, he seemed unable to comprehend the complacent inaction of his dam. But though always tense and energetic Romulus was tractible and docile". The rapid development of independence by the wild hybrid foal is again suggested by the fact that Romulus, at three days old was nibbling grass and a little later used hay and partook of his mother's oats. The Department of Agriculture at Washington made continued attempts to produce horse zebra hybrids,but have failed to get a mating. All attempts to impregnate the mares artificially, except one, also failed.

Ass x Zebra Hybrids.

Ass x zebra hybrids of several kinds have been produced, though this cross has not so often been attempted as the former. At the Animal Industry Bureau Experiment Station five female asses were turned loose with a zebra male. Whereas the zebra had paid absolutely no attention to several mares that had previously been confined with him, he showed much more attention to these new companions.[1] "After being with them almost daily for eight months he finally mated with one of the burros. Since then there has been no difficulty in getting a service, providing he sees no one, or nothing else attracts his attention. Eleven of these hybrids have been foaled, two colts and four fillies were alive at the time of the last report of the department. Riley says "considering the apparent similarity of the species to which asses and zebras belong there may be a possibility of their hybrids being fertile.

Compound Hybrids.

In the Knowsley Menagerie "there is a figure of a

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1. E. H. Riley, Bu. An. Ind. 26th Report.

triple hybrid, described as "off spring of a mule (ass zebra) with a bay mare pony." The color is iron grey, short narrow cross bands on withers, feint stripes on the sides, pale bushy like that of a horse, head heavy. This is an interesting animal, being the only authenticated case (as far as the writer can determine) of a compound hybrid among members of the horse genus. Darwin says, evidently referring to this animal[1] "many years ago I saw in the zoological gardens a curious compound hybrid from a mare by a zebra ass hybrid, it closely resembled its mother.

CLOSING REMARKS.

In this paper there has been presented information and data, collected from very many sources, which has a bearing on the matter of equine hybrids. The treatment of the subject has been of such a nature that deliberate statements of conclusions is unnecessary or impossible.

It may only be fitting to comment that the investigations so far, has revealed nothing which can be directly applied to improvement of the mule industry. Field work with users and breeders of mules is yet to be done, and it is hoped that some data more directly translatable into usefulness and conclusions may be secured in this way.

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BIBLIOGRAPHY.

American Jack Stock Stud Book, Vols. I-VIII.

Aristotle, Book of Wonder Stories.

Breeders Gazette, 1903-1911.

Burkett, Bailey's Cyclopedia of Agriculture, Vol. III.

Cowan, J. L., 1906 Apothesis of the Ass, Ov. Mo. 48 : 85.

Darwin, Charles, Animals and Plants Under Domestication, Vols. I & II.

Origin of Species, Vol. I.

Dickinson, Husbandry of the Ancients.

Dureau de le Malle, 1930, Ann. de Sci. Nat. 21 : 60.

Ewart, Cossar, 1904, Multiple Origin of Horses and Ponies, Smithsonian Report 1904.

Penycuik Experiments, 1899.

Fowler & Lydekker, Mammals Living and Extinct.

Griffith, P. M. 1905, Mo. Cons. Rep. No. 297, p. 193.

Grout, J. H., 1904, Mo. Cons. Rep. No. 244, p. 99.

Homer, Illiad.

Keller, C., Naturgeschichte der Haustier.

Live Stock Journal, 1905-1906.

Obrecht, R. C., 1908, Market Classes and Grades of Horses and Mules. Ill. Bul. 122.

Osborne, H. F., Age of Mammals.

Prescott, Conquest of Peru, Vol. I.

Ridgeway, Origin and Influence of the Thoroughbred Horse.

Riley, E. H., 1909, Zebra Hybrid Breeding, 26th Annual Report of the Bureau of Animal Industry.

Riley, Harvey, 1867, The Mule.

Sanson, Andre, 1888, Traite de Zootechnie, Tomes 3-5.

Shaler, N. S., Domestic Animals.

Standard Natural History, Vol., Mammals.

Stevens, Harold, Domestication of the Zebra, Cur. Lit. 27 : 72.

Suchetet, Andre, 1896, Des Hybrides a l Etat Sauvage, Vol. I.

Tegetmier and Sutherland, 1895, Horses, Asses and Mules.

Twelfth Census U. S. 1900, Vol. V.

Townshend, R. B., 1900, The Common Mule, Nineteenth Century, 47 : 130.

Van E. Iwanoff, 1905, Untersuchungen uber Unfruchtbarkeit von Zebroiden, Bio. Centbl., 25 : 789.

White, Edward Stewart, 1908, Burro or Mule for the Trail, Outing 51 : 115.

Whitehead, R. H., 1908, Function of Interstital Cells of Testes, Anat. Rec., 2 : 177.

Worder, J. T., 1863, An. Rep. Dept. Agr., p. 180.

Youatt, 1854, The Horse.

1893, Complete Grazier.

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