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ORIGINS, HISTORY AND RELATIONSHIPS OF INDIGENOUS AFRICAN CATTLE

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SUMMARY

With some 180 million head, comprising more than 150 different breeds or populations of taurine *Bos taurus*, indicine *B. indicus* and intermediate origin, the African continent is home to an enormous reservoir of cattle biodiversity. Recent archaeological findings are providing new insights into the origin and migration of cattle populations into Africa. They indicate that cattle pastoralism preceded cereal agriculture in most of Africa and that cattle were possibly domesticated within the continent from the African wild relative auroch *B. primigenius*. The early sites with evidences of domesticated African cattle are Bir Kiseiba and Nabta Playa in south Egypt (11000 BP - 6000 bp). Extensive molecular genetics studies at the International Livestock Research Institute (Kenya) and at Trinity College Dublin (Ireland) support an indigenous origin for African cattle. Moreover, autosomal and *Y*-specific microsatellite analyses have revealed in details the genetic relationships among the present day African breeds. Very little to no Asian zebu, Middle East or European taurine influences were detected amongst the West African taurine living within the tsetse fly zone. A major Asian zebu influence, which probably started around the seventh and eighth century AD, is clearly visible amongst the cattle populations of Eastern Africa and the Sahel. These populations are the result of interbreeding between African indigenous taurine and zebu of Asian origin. The predominantly taurine genetic background of the southern African sanga supports the archaeological view of an early arrival of cattle in the southern part of the continent before the major zebu influence in the Horn of Africa. The origin and history of present day African indigenous cattle demonstrate their unique genetic background. It strongly argues for their conservation and sustainable utilisation for future livestock production in Africa and elsewhere.

Keywords: Africa, cattle, microsatellites, domestication, mitochondrial DNA, Y chromosome.

Note: uncalibrated dates and time ranges are referred to as bp (before present) and bc. Calibrated dates and time ranges are denoted by upper case letters (BP, BC and AD).

INTRODUCTION

The African continent is the home of nearly 180 million cattle currently classified in at least 150 indigenous cattle breeds or strains (Rege *et al.*, 1996). Adapted to the local environmental conditions, they represent a unique genetic resource. Particularly valuable are their adaptation to heat and drought, their tolerance to diseases (e.g. trypanosomosis) and their capability to efficiently utilize low quality indigenous forages. They are extremely diverse phenotypically and they are currently classified in three main groups: taurine, zebu and sanga (supposedly zebu x taurine crossbreed) (Epstein 1971). However, intermediate types are also present and classification of some populations in the three groups is not always possible (see Rege and Tawah 1999). African indigenous livestock are today particularly at risk through unplanned crossbreeding and replacement with exotic breeds, ravages of drought, disease (e.g rinderpest) and civil conflict.

The history of African livestock is complex and still very debated. The most common view is that African cattle originated from the center of domestication in the Near East and subsequently reached the continent through the isthmus of Suez and the Nile valley, along the Mediterranean and the Atlantic littoral, along the coast of the Arabian Peninsula and/or through the Strait of Bab-El-Manbed (Payne and Hodges 1997). Contrary to this, an indigenous origin of African cattle has been suggested (MacDonald 2000). The last 10 years have seen an accumulation of new archeological and genetic data providing new lights on the origin and history of African cattle. In this paper these new data are reviewed.

The history of African cattle: archeological evidences

The discovery of remains of domesticated short-horn cattle dated 5100 ± 150 BP at Capéletti in Algeria and the presence of auroch (*Bos primigenius*) during the Neolithic in North Africa, in today Sahara and the Nile valley have raised the possibility of an indigenous center of origin for African cattle (Roubet 1978). Later, Grigson (1991) suggested that sanga cattle were descendants of cattle domesticated in North Africa. More recently, archeological findings at Bir Kiseiba and Nabta Playa in south Egypt provide evidence of cattle pastoralism as early as 11,000 BP to 6000 bp (Wendorf and Schild 1998, MacDonald 2000). If these latest evidences and dates are correct, cattle could have been domesticated in Africa before its domestication in the Fertile Crescent (around 8400 BP at ˈatal Hüyük in central Anatolia, Turkey) (Perkins 1969) as in the Indus valley (7000 BP at Mehrgarh, Pakistan) (Meadow 1984). Also, cattle pastoralism would have preceded cereal agriculture in Africa and the arrival on the continent of small ruminant from southwest Asia dated around 8400 and 8000 BP (MacDonald 2000). Such an African center of domestication is supported by linguistic evidences which trace back word roots connected to pastoralist activities to the 8th or 9th millemium BC (Ehret 1993). Osteological studies also support the thesis that domestic cattle in the Levant and North Africa have been distinct from one another since at least the fourth millenium bc if not earlier (Grigson 2000).

From this possible North East African center of origin, archeological evidences indicate that cattle reached West Africa by a least *c.* 6300 bp (MacDonald and MacDonald 2000) and the Central African region by 4[illegible]-3900 bp (Van Neer 2000), Eastern Africa by *c.* 3500-2000 bp (Marshall 2000) and the southern African region by *c.* 2000 bp (Smith 2000).

The early dates of arrival of zebu *Bos indicus* cattle on the African continent are still uncertain. Most likely the presence of these humped cattle was for a long time concurrent with the trading between the Horn of Africa, the Arabian Peninsula and the Indian sub-continent. Early presence of zebu cattle in the Abyssinian region is illustrated by Egyptian tomb painting dating about the second half of the 2nd millennium BC which clearly show humped cattle (Epstein 1991). It is, however, generally assumed that the major zebu arrival followed the Arab invasion of Africa from about 699 AD (Epstein 1971). They reached semi-arid West Africa before 1000 AD (Blench 1993) and dispersed further south with the Angoni, Malawi and Malagasy Zebu, the southernmost indigenous African zebu breeds (Felius 1995).

The history of African cattle: molecular evidences

Recent studies using molecular DNA markers at the International Livestock Research Institute and at Trinity College Dublin (Ireland) are providing new insight regarding the origins and the history of African cattle. It was first shown that the mitochondrial DNA, a maternally inherited DNA marker, of Asian zebu (indicine) and European taurine were clearly distinct (Loftus *et al.*, 1994). Bradley *et al.*, (1996) sequenced a 370-bp portion of the mitochondrial D loop of 28 African cattle belonging to four African breeds classified as taurine (N'Dama) or zebu (Butana, Kenana, White Fulani). These African sequences were compared with sequences from 42 European cattle and 20 Asian Zebu *B. indicus* and one Bison *Bison bison*. All sequences present in African breeds were unique to Africa and they were found to be closer to the European taurine family of sequences than to the indicine one. The same sequences were encountered both in African taurine and zebu. These results have been further confirmed with the analysis of more African breeds, including sanga cattle, from all the parts of the continent (D.G. Bradley personal communication). Mitochondrial DNA data have also enabled the calculation of the divergence time between the ancestors of domestic cattle in Africa, Europe and Asia. The separation time (22000-26000 BP) between the most common African and European haplotype is earlier than the first evidence of cattle domestication on the two continents (Bradley *et al.* 1996). This supports an indigenous origin of African cattle on the maternal side.

The first study to examine the African cattle *Y* chromosome at the DNA level was done by Bradley *et al.* (1994). The four African zebu breeds studied had only a zebu *Y* chromosome. Furthermore, some taurine populations of N'Dama had both the zebu and the taurine *Y* chromosome. More recently, a study examining for the first time indigenous cattle breeds representing all subregions of sub-Saharan Africa was completed (Hanotte *et al.*, 2000). A total of 984 males from 69 indigenous African populations or breeds from 22 countries were studied using a polymorphic *Y* specific microsatellite (INRA 124) showing two alleles (Hanotte *et al.*, 2000). One allele (length 130 base pairs) is zebu specific and the other allele (length 132 base pairs) is taurine specific. The study reveals the pattern of zebu introgression on the African continent in great details. It indicates that it is predominantly male mediated. Moreover, it shows that the Abyssinian region (Ethiopia, Eritrea, Sudan) is the main center of dispersal of African zebu populations with ninety-nine percent of the cattle of this area having an indicine *Y* chromosome. Similarly, the indicine allele was only observed amongst the zebu breeds of the sahelian belt. In West Africa, the zebu specific allele was detected in nearly all taurine populations. The only exceptions were among the taurine populations living deep within the tsetse-infested areas and the Kuri of Lake Chad. The results amongst the sanga breeds were surprising. Indeed, in the sanga Ankole and related strains as well as amongst the sanga from the southern part of the African continent, it is the taurine allele that is the commonest. Under a male-mediated model of zebu introgression the opposite would have been expected in these populations. It appears that the history of the African sanga is more complex than previously thought (see Hanotte *et al.*, 2000).

Autosomal microsatellite markers have also been used to unravel the history of African cattle (MacHugh *et al.*, 1997). Here, the use of microsatellite markers, with substantial difference in allele size distributions between Asian zebu and taurine cattle, is very useful to investigate zebu gene flow and zebu-taurine admixture in African populations. Phylogenetic trees have also been used to study the genetic relationships among African cattle (MacHugh *et al.*, 1997). They are however not reliable to study populations with different histories of admixture. Therefore, to reveal the major genetic influences in African cattle breeds, we have applied (O. Hanotte *et al.*, 200) unpublished data) an approach, pioneered by Cavalli-Sforza and colleagues for the study of human populations (Cavalli-Sforza *et al.*, 1994). It is based on principal component analysis of allele frequencies at microsatellite loci. Our results do not indicate a major Near East influence in the indigenous African cattle studied but we do find a major Asian zebu influence in all sub-Saharan cattle with the exception of some West African taurine populations living within the tsetse-infested areas.

CONCLUSION

It is estimated that the world demand for meat consumption will increase annually by nearly two percent for the next 20 years to reach a total meat consumption of 303 millions metric tons (Delgado 1999). Increase in livestock productivity will have to follow. The African indigenous livestock and their crossbreeds represent a unique genetic resource for further improvement of livestock productivity within the African continent and possibly also outside Africa. Both archeological data and molecular genetics studies are providing invaluable information on the history of the origin and diffusion of African cattle pastoralism. Such information is a prerequisite for future conservation and utilization efforts.

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