Indigenous African cattle breeds: Origins, classification and genetic diversity

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Introduction

The domestication of wild ox or aurochs (*Bos primigenius*) was one of the most significant achievements of early pastoral communities. It is believed that aurochs were domesticated to modern cattle (excluding Bali cattle and Mithan) by early pastoral communities around 10,000 years B.P. (Epstein 1971; Epstein and Mason 1984; Payne 1991). The breeding tracts of aurochs are assumed to have ranged over the old World, North Africa to Europe and Asia (Bradley *et al.* 1996). Three continental races of aurochs have been identified *viz.*, *Bos primigenius primigenius* in Europe, *Bos primigenius namadicus* in Asia and *Bos primigenius opisthonomus* in North Africa (Loftus *et al.* 1994). It is hypothesized that aurochs probably extinct from these regions around 2000 years ago, but may have survived into medieval times in central Europe (Payne 1991). Today, there are two major cattle types derived from aurochs, zebu (humped) and taurine (humpless) cattle. These cattle types are named as separate species (*Bos indicus* and *Bos taurus*), but owing to absolute inter-fertility they are usually recognized as sub-species.

There are two schools of thought on the domestication of these two sub-species of cattle. The first opinion asserts that domesticated cattle (*Bos taurus*) were first derived from a monophyletic wild ancestor (*Bos primigenius*) in the Near East about 8,000–10,000 years ago. *Bos indicus* populations were then thought produced at a later date through selection and breeding from the domesticated *Bos taurus* cattle (Epstein 1971; Epstein and Mason 1984; Payne 1991). The alternative view point supported by recent archaeological and molecular evidences is that domestication of zebu cattle was carried out independently by a separate group of early pastoralists in Asia (Meadow 1993; Loftus *et al.* 1994; Bradley *et al.* 1996). The archeological remains that demonstrate the

presence of Asian sub-species of aurochs, *Bos primigenius namadicus*, at early agricultural sites in Asia may also represent the likely progenitor of *Bos indicus* cattle supporting separate domestication (Bökönyi, 1985). Additionally, the degree of divergence between indicine and taurine cattle based on variations within the mitochondrial DNA displacement loop (mtDNA D-loop) between *Bos* and *Bison* species was estimated as 740,000 years B.P. a time frame that precedes domestication (Loftus *et al.* 1994). This analysis was interpreted as evidence for a pre-domestic and separate origin for *Bos indicus* and *Bos taurus* cattle progenitors.

In addition to their history of origin, information concerning the number of breeds, population sizes as well as the amount of genetic variation are important for future sustainable cattle utilization and conservation. The status of cattle breeds in developed countries is well known and documented. However, relatively little is known about cattle in Africa and other developing countries. Indeed, it is in these developing countries where many genetically unique and best adapted animals are found today. It is also in these regions where breeds are in greatest danger of extinction. Unfortunately, lack of adequate information from regions possessing the greatest diversity give an incomplete and distorted picture of the status and trends of cattle breeds worldwide. This paper briefly outlines the current understanding of origin, classification and genetic diversity of indigenous African cattle breeds.

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Origins of domestic cattle of Africa

The history and origin of African cattle remained controversial and poorly understood until the recent decade. Today, there are two points of view on the origin of African domestic cattle. The first point of view underlines that domestic cattle could have been introduced into Africa through successive migrations from the Near East where cattle domestication is known to have taken place (Epstein 1971; Grigson 1989). Alternatively, the recent widely accepted view point asserts that African species of wild cattle or aurochs (*Bos primigenius*) may have been domesticated (African taurine) possibly in the North East part of the continent (Wendorf and Schild 1994; Bradely *et al.* 1996; Hanotte *et al.* 2002). The subspecies ancestor of domesticated African cattle is unclear. In literature sometimes it is referred as *Bos primigenius opisthonomus* (Grigson 1991) or *Bos primigenius africanus* or *Bos primigenius mauritanicus*.

Analysis of mitochondrial DNA (Bradley *et al.* 1996) and autosomal microsatellite markers (Hanotte *et al.* 2002) provide a clear picture on the origin of African domestic cattle. In a recent report entitled, "African pastoralism: genetic imprints of origins and migrations" Hanotte *et al.* (2002) have identified that the earliest cattle (*Bos taurus*) were domesticated within the African continent. In this investigation they also suggested the existence of Near East and European cattle genetic introgression into African cattle. The pattern of dispersal of domestic cattle within the continent further clarified that the initial expansion of African *Bos taurus* was likely from a single area of origin reaching the Southern part of the continent following an Eastern route rather than a Western one. These Molecular data also indicated that Asian *Bos indicus* genetic introgressions occurred presumably through the Horn and East Coast of Africa; via two modes of introgression. The process of introgression may have taken place over millennia and the major influx of thoracic humped zebu cattle into Africa is hypothesized to have occurred after Arab invasions of the 7th century AD (Epstein 1971). The pattern of zebu genetic introgression was thought to be male-mediated as revealed from genetic data (Loftus *et al.* 1994; Bradely *et al.* 1996). According to these molecular data reports, no *Bos indicus* mitochondrial DNA haplotypes have been found in the African continent,

implying male-mediated zebu introgression into the continent.

African cattle breeds and their classification

Cattle are the most important type of animal kept in many African countries. They form the basis of life for millions of people across the continent. Almost all African cattle breeds perform multiple functions, for instance food (milk, blood, ghee, meat), traction (cultivation, transport), manure (fertilizer, fuel for cooking food), marriage and related needs, wealth store (bank account that can be converted to cash), ceremonies and rituals, skins (used for bedding, sandals, belts etc), status (some one with many cattle is respected).

In total, more than 145 indigenous breeds/strains of cattle inhabit in the sub-Saharan Africa (Rege 1999; Rege and Tawah 1999). They represent various cattle types ranging from the Asiatic thoracic-humped zebu cattle to crossbred cervico-thoracic humped Sanga cattle. The successive introduction of zebu cattle from Asian that interbred with the original African taurine cattle resulted in several varieties of African cattle breeds. Additionally, migrations of pastoralist within and across the countries in search of water and pasture for livestock encourage extensive interbreeding that may have contributed to the development of varieties of African cattle.

Based on an extensive survey of cattle breeds by Rege (1999) and Rege and Tawah (1999), sub-Saharan African cattle breeds are classified into four major categories: Zebu (*Bos indicus*), Humpless cattle (*Bos taurus*), Zenga (Zebu-Sanga) and Sanga (Table 1). Recently developed derivative breeds are also recognized as separate fifth and sixth categories. In the sub-Saharan Africa, 75 Zebu, 17 humpless cattle, eight Zenga and 30 Sanga breeds are recognized. There are also nine breeds developed from interbreeding of indigenous breeds located in close proximity to each other, and six systematically created composite breeds.

Zebu's are further categorized into small and large East African Zebu cattle. These variations in body size are to have developed in response to environmental adaptation; otherwise their evolutionary origin is similar. Zebu cattle

Table 1. Partial list of indigenous African cattle breeds/strains

Group	Breed name	Location/country	Main uses (ranked by importance)
Zebu	Arsi	Ethiopia	Work, meat, milk
	Boran	Ethiopia	Meat, milk
	Barka	Eritria	Milk, meat
	Turkana	Kenya	Milk, meat
	Teso	Kenya, Uganda	Milk, meat, work
	Duruma	Kenya	Meat, milk, work
	Nandi	Kenya	Milk, work, meat
	Kamba	kenya	Meat, milk, work
	Ogaden	Ethiopia	Milk, meat, work
	Adwa	Ethiopia	Work, meat, milk
	Sokoto	Nigeria	Milk, meat, work
	Kenana	Sudan	Milk, meat
	White Fulani	Nigeria, Cameroon	Milk, meat, work
	Lugware	DR Congo, Congo	Work, meat, milk
	Red fulani	Nigeria, Cameroon	Milk, meat, work
	Kavirondo	Kenya	Milk, work, meat
	Madagascar zebu	Madagascar	Meat, milk, work
	Angoni	Zambia	Meat, work, milk
	Garre	Somalia	Milk, meat
	Chagga (Wachagga)	Tanzania	Milk, meat, work
Humpless Cattle	Bakosi	Cameroon	Meat, rituals
	Baoulé	Central Africa Republic, Ivory Coast, Gabon	Milk, meat
	Doayo (Namchi)	Cameroon	Meat, rituals
	Ghana Dwarf Muturu	Ghana	Meat, work, milk
	Lagune	Benin, Ivory Coast, Togo	Meat, manure
	Liberia Dwarf Muturu	Liberia	meat
	Logone	Chad	meat
	Forest Muturu	Nigeria	Meat, rituals
	Sheko	Ethiopia	Milk, meat, work
	Kuri	Chad, Niger, Nigeria	Meat, milk, work
Zenga (Zebu-Sanga)	N'Dama	West & Central African	Meat, work, manure
	Horro	Ethiopia	Work, milk, meat
	Fogera	Ethiopia	Work, milk, meat
	Bovines of Tete	Mozambique	Meat, milk, work
	Jiddu	Somalia	Milk, meat
	Arado	Ethiopia, Eritrea	Work, milk, meat
	Alur (Nioka)	DR Congo	Milk, meat, work
Sanga	Nganda	Uganda	Milk, meat, work
	Sukuma (Tinde)	Tanzania	Milk, meat
	Africander	South Africa	Meat, work
	Barotse	Angola, Zambia	Milk, meat, work
	Damara (Herero)	Namibia	Milk, work, meat
	Danakil	Ethiopia	Milk, meat, work
	Humbi	Angola	Meat, work, milk
	Mashona	Zimbabwe	Meat, work
	Nguni	Swaziland, South Africa	Meat, work, milk
	Okavango	Namibia	Meat, work, milk
	Ovambo	Namibia	Meat, work, milk
	Raya-Azebo	Ethiopia	Milk, meat, work
	Shilluk	Sudan	Milk, meat
	Tonga	Zamia	Milk, meat, work
	Tuli	Zimbabwe	Meat
	Aliab Dinka	Sudan	Milk, meat
	Kigezi	Uganda	Milk, meat, work
	Pedi	South Africa	Meat, work, milk
	Nuer	Sudan	Milk, meat

Source (Rege 1999; Rege and Tawah 1999)

are characterized by hardened hooves, lighter body and low water requirements. These traits enable them to tolerate dry and harsh conditions of the tropics for endured long migrations. They are widely distributed in Eastern and dry parts of West Africa. They have no innate resistance to trypanosomiasis and have started to inhabit the humid regions with the assistance of veterinary prophylaxis and the destruction of tsetse habitat through deforestation. Changing ecological conditions from humid forests to dry conditions have hastened the dispersal of zebu genes to different parts of the continent.

Bos taurus cattle are grouped into two, longhorns (*Bos taurus longifrons*) and shorthorns (*Bos taurus*

brachyceros), which are both restricted to humid trypanosomiasis infested East, West and Central Africa. N'dama and Kuri cattle are the only longhorns *Bos taurus* cattle found in Africa. African *Bos taurus* cattle possess inherent resistance to trypanosomiasis and other tropical diseases. However, these populations are increasingly under threat of genetic erosion from zebu cattle.

Zenga are considered to be recent derivatives and they are mainly found in Eastern Africa. Zenga breeds are believed to have developed after the initial cattle plague (rinderpest) epidemic and decimation of the dominant Sanga breeds of East Africa. Zebu cattle were introduced from Asia into Africa at various points on the East Coast

Boran

Sheko

Horro

Raya-Azebo

Fig. 1. Typical indigenous African cattle breeds

and Horn of Africa. This provided opportunity for zebu to interbreed with remnants of Sanga and produced several Zebu-Sanga and Sanga-Zebu admixture populations (Rege 1999). Sanga are mainly found in Eastern and Southern Africa. These breeds are thought to be the result of hybridization between the initial zebu cattle that entered Africa and original African longhorn taurine cattle (Epstein 1971; Manwell and Baker 1980).

Risk status and future conservation prospects of African Cattle

There is a general concern that, among the livestock breeds existing today, 70% are in developing countries where the risk of extinction is high (Rege and Gibson 2003). In recent reports 22 breeds which existed in Africa at some time during the 20th century can not be located in recent times, as a result they are considered extinct while 47 cattle breeds are identified to be at risk (Rege 1999). Four risk statuses have been defined by Food and Agricultural Organization (FAO 1992): Critical (most threatened), Endangered, Vulnerable and Rare (least threatened). Proportion of African indigenous cattle breeds falling within these different risk statuses are presented in Fig. 2. From all the breeds identified 32% are at risk of endangerment while 10% are critically endangered breeds. Many African cattle breeds at risk of extinction may possess unique characteristics that may be useful in confronting newly born tropical diseases and other challenges in the years to come. Traits such as resistance to diseases and adaptation to climatic extremes could prove fundamental to

food security for the present and future generations, particularly in developing countries.

The loss of local breeds or varieties usually results in irreversible loss of the genetic diversity. This may have wide ranging negative effects on both natural and human populations that depend on them. To curtail loss of cattle genetic resources, effective conservation programmes should be designed and implemented in respective countries. The most economically feasible method recommended for preserving livestock genetic diversity in Africa and the rest of the developing countries is *in-situ* conservation of live animals (FAO 1992). *In-situ* conservation enables breeds to adapt and be selected for use in their natural environments and traditional management systems. Unlike cryogenic (*ex-situ*) techniques, which require advanced technology and knowledge for collection and storage of biological material, *in-situ* conservation can be carried out at any level with the skills and resources already available. In fact it is important to consider cryogenic storage method as a last resort or supplement to *in-situ* conservation for populations at risk where economic and technical feasibility permits its implementation.

Genetic diversity of indigenous African cattle breeds

Although Africa is home to many native breeds, there is limited breeds information from molecular data. Molecular characterization explores biochemical biodiversity of both protein and DNA markers polymorphisms so as to measure the degree of genetic variation at the population level. Because of the low level of polymorphisms observed in protein markers, DNA-level polymorphisms are currently the markers of choice for assessment of accurate genetic diversity in populations. This report highlights results based on only autosomal microsatellite markers variations in African cattle.

Fig. 2. Proportion of indigenous African cattle breeds falling within different risk status categories (excluding extinct breeds)

The mean number of alleles, observed and expected heterozygosities for some African cattle breeds are presented in Table 2. The mean number of alleles range from 4.3 in Butana to 8.00 in Maasai cattle. The mean expected heterozygosity per breed range from 0.512 in Muturu to 0.74 in Maasai and Teso breeds. With the exception of East African Sheko, heterozygosity values are

Table 2. Genetic diversity of some African cattle breeds, mean number of alleles ($\hat{A}$), observed (H_O) and expected (H_E) heterozygosities

Breed	$\hat{A}$	H_O	H_E	Reference
Zebu cattle				
Duruma	6.90		0.707	Rege <i>et al.</i> 2001
Ethiopian Borana	7.20		0.718	Rege <i>et al.</i> 2001
Giriama	5.10		0.724	Rege <i>et al.</i> 2001
Kovirondo	6.90		0.724	Rege <i>et al.</i> 2001
Maasai	8.00		0.740	Rege <i>et al.</i> 2001
Nandi	7.90		0.734	Rege <i>et al.</i> 2001
Taveta	7.10		0.731	Rege <i>et al.</i> 2001
Teso	7.20		0.740	Rege <i>et al.</i> 2001
Turkana	7.80		0.735	Rege <i>et al.</i> 2001
Arsi	7.10	0.686	0.726	Unpublished [†]
Ogaden	7.13	0.667	0.728	Unpublished
Ambo	7.17	0.70	0.719	Unpublished
Adwa	7.50	0.685	0.734	Unpublished
Butana	4.30	0.652	0.599	MacHugh <i>et al.</i> 1997
Kenana	4.90	0.643	0.619	MacHugh <i>et al.</i> 1997
Gobra	5.90	0.633	0.634	MacHugh <i>et al.</i> 1997
Maure	6.20	0.631	0.658	MacHugh <i>et al.</i> 1997
White Fulani (Nigeria)	4.80	0.610	0.636	MacHugh <i>et al.</i> 1997
Sokota Gudali		0.697	0.731	Ibeagha-Awemu <i>et al.</i> 2004
Bonyo Gudali		0.654	0.724	Ibeagha-Awemu <i>et al.</i> 2004
Ngaoundere Gudali		0.692	0.703	Ibeagha-Awemu <i>et al.</i> 2004
Humpless cattle				
N'Dama	6.40	0.540	0.549	MacHugh <i>et al.</i> 1997
Muturu		0.506	0.512	Ibeagha-Awemu <i>et al.</i> 2004
Namchi		0.549	0.656	Ibeagha-Awemu <i>et al.</i> 2004
Sheko	6.93	0.647	0.735	Unpublished
Zenga				
Horro	7.30	0.692	0.722	Unpublished
Fogera	7.17	0.691	0.731	Unpublished
Sanga				
Danakil	7.03	0.671	0.723	Unpublished
Raya-Azebo	7.03	0.667	0.714	Unpublished

[†] Unpublished manuscript (Dadi *et al.* 2007)

low in *Bos taurus* as compared to other breeds. The low level of heterozygosity observed in West African *Bos taurus* cattle is supported by their low population sizes (Ibeagha-Awemu *et al.* 2004). Overall, a large spectrum of genetic diversity exists in African cattle. Some populations reveal

high while others reveal low genetic diversities. High genetic diversity is presumably a result of past admixture between *Bos indicus* and *Bos taurus* cattle and lack of systematic genetic selection in many African cattle populations. Generally, variations between genetic

diversities in African cattle breeds mainly reflect their different evolutionary history.

Conclusion

Africa possesses a variety of indigenous cattle breeds/strains in its diversified agro-ecologies. The advantage of having such a large number of breeds will allow development of new breeds in response to unpredictable changes in environment, threats of disease, new knowledge of human nutrition requirements, changing market conditions and societal needs. However, many valuable African cattle breeds are currently at risk of extinction (*e.g. Bos taurus*). The extinction of these breeds narrows down the cattle genetic resource base and options for future breeds genetic improvement. This unfortunate situation should be minimized by promoting rational and effective conservation programs for breeds at risk in their native habitats.

Proper definition and classification of African cattle breeds is still deficient. Breeds are classified based on historical evidence and phenotypic characteristics. Reliance on this information as a basis for classification of cattle breeds for future genetic improvement, development and conservation in most cases is quiet misleading. Alternatively, adequate genetic characterization of these populations is a prerequisite for their successful and sustainable genetic improvement and conservation in Africa.

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