

Debate on the authenticity of *Pseudonovibos spiralis* as a new species of wild bovid from Vietnam and Cambodia

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INTRODUCTION

In the February 2001 issue of the *Journal of Zoology*, a paper was published by Robert Timm and John Brandt (2001) that provided a new identification for two bovid frontlets held in the Kansas Natural History Museum. The frontlets had been collected in 1929 from Suoi Kiet, Binh Tuy Province in Vietnam and had been previously identified as kouprey *Bos sauveli*. Timm and Brandt re-identified the two frontlets as adult male and female representatives of the recently described spiral-horned ox *Pseudonovibos spiralis* Peter & Feiler, 1994.

At the same time as the publication of Timm and Brandt's report, a number of other accounts appeared in the scientific and popular press claiming that *Pseudonovibos spiralis*, far from being a newly discovered species of wild bovid (but known only from its horns and frontlets) was a fake constructed by local people for their own ritual or medicinal purposes. It was therefore decided that the principal authors of the opposing theories on the authenticity or fraudulence of the known specimens of horns and frontlets, ascribed to *Pseudo-*

novibos spiralis, should be invited to contribute the results of their researches to a published debate. Accordingly the case for the authenticity of the species is given first by Timm *et al.* and this is followed by three accounts by Hassanin, Melville, and Seveau who do not believe in the existence of *Pseudonovibos spiralis* as a newly discovered wild bovid.

Key words: Bovidae, spiral-horned ox, *Pseudonovibos spiralis*, Khting Vor, Vietnam, Cambodia

WHAT IS PSEUDONOVIBOS SPIRALIS?

Although the question 'What is *Pseudonovibos spiralis*?' seems simple, the answer involves systematics, historical animal husbandry, and folklore. Is this enigmatic bovid a naturally occurring ox or a hoax created by post-mortem modification of cattle skulls? The genus and species were described in 1994 from horn sheaths that were purchased from markets in Vietnam and believed to be from six animals (Peter & Feiler, 1994*a,b*). The species is known only from horn sheaths or frontlets with horn sheaths; however, several specimens attributed to *P. spiralis* actually represent other species of

bovids (Timm & Brandt, 2001). Because the validity of *P. spiralis* has recently been called into question (Hassanin *et al.*, 2001; Thomas, Seveau & Hassanin, 2001), we herein briefly review what is known.

All specimens reported or purported to belong to *P. spiralis* have come from either Cambodia or Vietnam, and most were from markets. Only two specimens, those at the University of Kansas, are from a specific region, the Suoi Kiet region of Vietnam. Most of the other specimens were purchased from animal and trophy markets in Phnom Penh, Saigon, or central Vietnam. Specimens reported as *P. spiralis* actually belong to several different species of bovids (Timm & Brandt, 2001), and specimens that clearly have been altered by humans exist. Hassanin *et al.* (2001), Seveau (2001) and Thomas *et al.* (2001) documented how fake specimens are made, concluding that the species is a hoax and the specimens are fakes that have been modified by humans from domestic cattle *Bos taurus* skulls. We have seen fake horns fashioned from Asian water buffalo *Bubalus bubalis*, as well as cattle. Dioli has seen buffalo horns that were skilfully crafted; their large diameter allowed the carving of both annulations and a spiral tip from the body of the horn.

Are all specimens fakes? The two specimens from Suoi Kiet (and several others) are not human-created artefacts. The horn annulations have not been carved or engraved and the twisted tip is a result of natural growth. The horns are associated correctly with the bony frontlets as judged by a perfect match between the longitudinal grooves of irregular bone that correspond with the longitudinal grooves and ridges in the sheaths. Radiographs of the horn tips reveal cone-shaped growth lines, which are deposition lines of the keratinous horn sheath that were laid down by natural growth (Fig. 1). The lack of distortion in these nested cones of keratin through the length of the twisted horn tip indicates that the horns were not modified after the death of the animal by heating and bending to create the twist. These internal depositional lines should not be confused with the strands of keratin that follow the length of the horn and can be seen externally. These deposition lines, and not the external annulations, are growth indicators from naturally produced horn. Human post-mortem modifications would have caused deflection in these growth lines. We have found similar depositional lines in the horns of European bison, gaur and kouprey. In the horns of male banteng, bison, gaur, kouprey and some ancient breeds of domestic cattle, the outer layer of keratin is shed, beginning near the horn tips, which results in a frayed appearance. Because of this breakdown of the horn structure, depositional lines are lost. Wharton (1957) referred to these as the inner and outer layers of the horn, and male kouprey fray off the outer layers beginning at 7 years of age. In North American bighorn sheep the deposition lines are laid down in annual increments, with the innermost lines being the youngest (see Goss, 1983, for a review of horn sheath growth). If post-mortem heating and twisting of the sheaths had been responsible for the curved tip, these

modifications would have caused distortions in the growth lines.

Why fakes are made is a question for which we do not have a definitive answer. Perhaps the reasons vary between regions and craftsmen. Modern-day Khmer hunters believe this animal has medicinal powers; the horns are believed to provide protection against snakes and are used as a cure for snakebite (Dioli, 1997; Thomas *et al.*, 2001; Timm & Brandt, 2001). Desai & Lic (1996: 34) reported that 'Both the Kouprey and *P. spiralis* are extremely rare with hunters specifically targeting them for their horns which are in great demand and fetch high prices'.

The local name Linh Duong and the Khmer names Khting Vor and Khting Sipuoh are used in the literature for this animal. However, Linh Duong refers to the serow *Nemorhaedus sumatraensis* in Vietnam. Timm & Brandt (2001) review what is known about *Pseudonovibos* and propose the name spiral-horned ox, reflecting the distinctively shaped horns, the specific name, and the close relationship to the other wild oxen. This is the one common name available that is unambiguously associated with this animal. Additional observations on the biology, distribution, and folklore associated with *P. spiralis* have been provided by Dioli (1995, 1997) and Nadler (1997).

Does *Pseudonovibos* differ from *Bos*? The new genus was proposed by Peter & Feiler (1994a,b) because the horns are annulated throughout their entire length and the tip is twisted, a distinctive combination of characters unknown in any other bovid. Based on morphological characters, Timm & Brandt (2001) placed the animal in the tribe Bovini. The frontlets from Suoi Kiet (see figures in Timm & Brandt, 2001) and several from elsewhere in Vietnam and Cambodia with the distinctive horns can be characterized morphologically as having: (1) horns set high on top of the skull, approximately oval in cross section; (2) horns relatively smooth at bases with bases divergent and wide-set laterally; (3) pneumatization of the skull pronounced; (4) frontals flat and not enlarged, with posterior margin forming a ridge or crest between the horns. This combination of characters places the animal in the genus *Bos* following the definition provided by Groves (1981).

Three separate molecular studies employing mitochondrial DNA sequences obtained from historic *P. spiralis* specimens differ in their phylogenetic conclusions, suggesting a nested position within the Caprini (goats and their allies; Hammer *et al.*, 1999), a sister relationship to water buffaloes (genus *Bubalus*; Kuznetsov *et al.*, 2001), or identity with domestic cattle (Hassanin *et al.*, 2001). However, the authenticity of the sequences reported in the first two studies has been called into question, and molecular evidence collected in independent laboratories now strongly supports a phylogenetic position closely related to, or within, domestic cattle (Hassanin *et al.*, 2001; L. Olson *et al.*, pers. comm.). Therefore, the morphological and molecular evidence both suggest that the genus *Pseudonovibos* is not a taxon distinct from *Bos*.

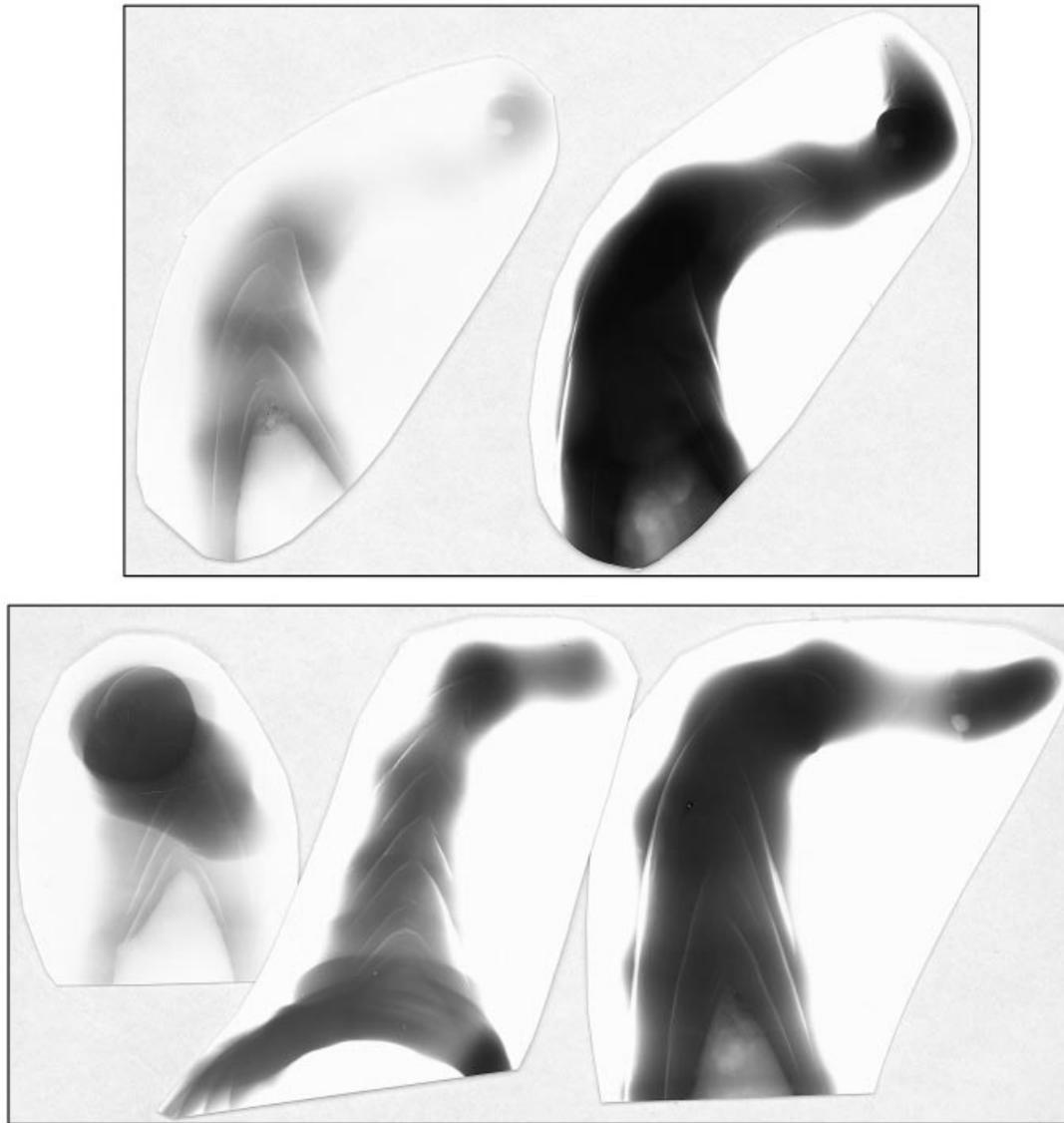


Fig. 1. Radiographs taken from different angles and exposures of the left horn sheath of two spiral-horned oxen from Suoi Kiet, Vietnam: top, KU 138657; bottom, KU 138658.

The distinctive horn sheaths of the spiral-horned ox with the annulations and terminal twist are not known from any other wild species of *Bos*, nor are they known from any breed of domestic cattle. However, in elucidating the species-level question we also need to ask, ‘What are cattle?’ Modern cattle were domesticated from the now extinct aurochs *Bos primigenius*, which ranged throughout much of Eurasia. The taurine cattle breeds (*B. taurus*) are of Near East origin and the Indian zebu *Bos indicus* is from the Indian subcontinent. Archaeological and molecular evidence indicates that there was independent domestication of *B. indicus* from the Asian form of *B. primigenius*, named *Bos namadicus* (Grigson, 1980; Bradley *et al.*, 1996; Troy *et al.*, 2001). *Bos taurus* and *B. indicus* are now known to comprise two distinct mitochondrial DNA lineages with an estimated predomestication divergence dating to well over 100 000 years bp. The *B. taurus* mtDNA haplotype

subsequently diverged from *B. primigenius* (Loftus *et al.*, 1994; Troy *et al.*, 2001).

Pertinent to the genetic information on the zebu breeds of cattle in South-east Asia is a statement from M. Edgar Boulangier’s (1888: 207) account of hunting Cambodian bovines. Our translation of his comments on cattle is as follows: ‘The Cambodians will search for certain wild oxen to cross with domestic races, so as to give them more robust shanks, and a greater size. Needless to say, they can take only the young ones.’ This statement documents that at least one species (and perhaps more than one) of wild South-east Asian bovid was bred with domestic cattle during the 19th century. Wharton (1957) also suggested that kouprey were interbred with domestic cattle in Cambodia. Intentional breeding of domestic cattle with wild species of *Bos* was and continues to be a widespread practice in southern Asia. Banteng *Bos javanicus*, gaur *Bos gaurus* and yak

Bos grunniens are actively crossbred with domestic cattle to increase muscular development as well as fat content in milk (National Research Council, 1983). This hybridization of domestic cattle with wild species of *Bos* along with presumably intense selection pressure by humans for desired traits has the potential to obscure our understanding of the evolutionary genetics of South-east Asian bovines, both wild and domestic. Interpretation of data from sex-linked and autosomal molecular markers such as those being used to assess species boundaries must therefore take account of the distinct possibility that genetic samples from single individuals might actually contain DNA from two or more recognized species.

The spiral-horned ox may be unique in all of zoology because erroneous material attributed to the species outnumbers properly identified specimens. This erroneous material includes many specimens altered by humans, as well as misidentified specimens belonging to other taxa. The recent assertion that all specimens are forgeries and that this entire species is a hoax do not account for the authentic specimens from Suoi Kiet and others. Contrary to the statements of Hassanin *et al.* (2001), Seveau (2001) and Thomas *et al.* (2001), an ox of the genus *Bos* with annulated horns and a twisted tip did exist in Vietnam and Cambodia. The spiral-horned ox is clearly a member of the genus *Bos*, which included the banteng, gaur, kouprey, yak, domestic cattle and the extinct aurochs. The origins, original distribution, relationships to other bovines, and current status of the spiral-horned ox all need to be further explored.

R. M. T., L. E. O., J. H. B. and M. D.

DID THE 'LINH DUONG' BOVID (*PSEUDONOVIBOS SPIRALIS*) EVER REALLY EXIST?

In 1993, several unusually shaped horns, collected from markets in Vietnam and Cambodia, were considered to be evidence for a new bovid species, *Pseudonovibos spiralis* (Peter & Feiler, 1994a,b). The horn sheaths seemed to be unique, having a distinct lyriform twist, as well as annulations throughout their entire length. This animal, named 'Linh Duong' in Vietnam or 'Kting Voar' in Cambodia, was known only from detached horn sheaths or frontlets with horns. The lack of other anatomical information was responsible for the confusion regarding the taxonomic status of this species and morphologists debated whether it was a close relative of the tribe Antilopini (gazelles) (Peter & Feiler, 1994a), Caprini (goats, sheep and allies) (Nadler, 1997), or Bovini (oxen, bison, and buffaloes) (Timm & Brandt, 2001).

Given the lack of morphological data on this species, the molecular approach appeared to be the only way of solving the question of the phylogenetic relationships of *P. spiralis*. However, the three different DNA studies that were carried out gave rise to three conflicting hypotheses:

(1) Hammer *et al.* (1999), using a 415-bp DNA fragment of the cytochrome *b* gene, proposed affinities with the Caprini *sensu lato*. However, Hassanin & Douzery (2000) challenged the authenticity of their sequence and interpreted it as the result of DNA contamination from chamois *Rupicapra rupicapra* in the laboratory.

(2) Hassanin *et al.* (2001) revealed that certain horns are simply cow horns that have been artificially carved and twisted. Two distinct DNA markers were sequenced from four trophies of *P. spiralis* collected in Indochina during 1925: a 243-bp fragment of the mitochondrial cytochrome *b* gene, and a 327-bp fragment of the nuclear lactoferrin gene. The phylogenetic results showed that the enigmatic horns of Linh Duong belonged to domestic cattle *Bos taurus* (Hassanin *et al.*, 2001). Morphological inspection indicated that the horn sheaths, originally smooth, had been carved to create the annulations, while the twist in the upper part of the horns was made by artificial torsion (Thomas *et al.*, 2001). This raised the question of whether all horns of the Linh Duong are bogus or not. In other words, did the species *P. spiralis* ever really exist?

(3) Most recently, Kuznetsov *et al.* (2001) suggested that *P. spiralis* was a new species of buffalo on the basis of a 962-bp DNA fragment of the 12S rRNA gene. However, I demonstrated (submitted) that their conclusion was wrong because the putative sequence of *P. spiralis* was shown to be a chimera obtained from three different species: *Bos taurus*, *Bubalus bubalus* (domesticated Asian water buffalo) and *Saiga tatarica* (saiga antelope). In addition, several factors indicated that their specimen was artificially made using horns and a frontlet from domestic cattle *B. taurus*.

In conclusion, and on the basis of the following three arguments, I can safely assume that, in all likelihood, all specimens of *P. spiralis* are fraudulent, and that the animal named 'Linh Duong' in Vietnam or 'Kting Voar' in Cambodia never existed in the wild.

(1) To date 21 specimens were collected in Cambodia and Vietnam. Six are described in Peter & Feiler (1994b); six in Dioli (1997); two in Timm & Brandt, 2001; six in Thomas *et al.* (2001); and one in Kuznetsov *et al.* (2001). Five of these have been molecularly interpreted as being bogus, being derived from cow horns (Hassanin *et al.*, 2001; Hassanin, submitted).

(2) The five specimens identified as fakes (four described in the paper of Hassanin *et al.*, 2001 and one in the paper of Kuznetsov *et al.*, 2001) differ in no perceptible external way from the others (Peter & Feiler, 1994a,b; Dioli, 1997; Timm & Brandt, 2001).

(3) All horns putatively assumed as authentic specimens of *P. spiralis* were collected at around the same date as other horns that have been identified as being bogus: 1929 for the two specimens housed in the collections of the University of Kansas Natural History Museum (Timm & Brandt, 2001) and 1925 and 1920 for the faked specimens, analysed by Hassanin *et al.* (2001) and Kuznetsov *et al.* (2001). This suggests that all horns were made at the beginning of the 20th century by a

small community of Vietnamese or Cambodian people and that this forgotten ethnic practice was restricted in time and place.

A. H.

***PSEUDONOVIBOS SPIRALIS* (? ARTIODACTYLA: BOVIDAE): CORRECTING MISINFORMATION**

Timm & Brandt (2001) wrote that Khting Vor, 'is the one common name available that we can unambiguously associate with the supposed new bovid *Pseudonovibos spiralis*', while Dioli (1997) wrote that in Cambodia, 'the animal is well known to local people. Its name in the Khmer language is Kting Voar or Kting Sipoah: 'wild cow that eat snake'.

A year-long survey of historical literature on Cambodian mammals, searching for mention of the Khting Vor or for any reference to a mammal identifiable as *P. spiralis*, has yielded only one important manuscript written between 1959 and 1962. This provides seminal new information on the use of the names Khting Vor and Khting Sipoah. The author is Hoer Lay Inn, Cambodian Minister of Agriculture in the 1950s, a dedicated naturalist who provided assistance to Wharton and Coolidge (who had seen and described the kouprey), and a colleague of C. Dumas, author of the reliable *La Faune Sauvage du Cambodge* (1944). Hoer's family had controlled large forest reserves in north-east Cambodia for generations, and he lived among the hill-tribes for 40 years. His memoir contains much information on the fauna of Cambodia, particularly with regard to Kratie and Mondolkiri provinces (inhabited by kouprey, gaur, banteng and wild water buffalo), and provides many pictures and precise locality information.

With regard to the gaur, Hoer wrote (my translation) that his, 'compatriots ask me frequently for a piece of horn from the Khting Pouh (serpent Gaur) for medicinal purposes and say emphatically that the Khting Vor (creeper [vine] Gaur) does not interest them at all. Personally I see no difference between the two varieties of this species, if there are varieties. Lacking a trophy (which I would never allow to be cut up) they content themselves with the hooves.'

Hoer and Dumas shot many gaur (I hunted with them occasionally), and observed variations pertaining to locality, individual, age, colour and sexual dimorphism in their kills. Had species-level differences been perceived, Dumas (1944) would have noted them. Note that Hoer was a French-trained agronomist, unencumbered by traditional Khmer myths and folklore. It is clear from the context of the paragraph that Khting Vor and Khting Sipoah are synonymous names for the gaur.

This is the earliest reliable written record that treats Pouh and Vor together in quite this way. Pouh is also written as Sipoah, Po, Pos, and Vor as Vohr and Voar. There are other Khting modifiers: Cha, Chea, Choar, Slik, Slek, Sluk, and Tia. Written Khmer is cuneiform, and transliteration into the Latin alphabet has been subject to two competing orthographies, in addition to

English/French differences. Add the shifting boundary between biology and myth in Cambodia, and scientists must tread warily in proposing biological associations for Khmer animal names. Anthropology contains many references to humans ascribing paranormal powers to animals, while a Cambodian analogy is provided by the huge gaur, grey-black, solitary, elusive and often turning hunter into prey. The Dictionary of the Buddhist Institute (1967: 108) lists only a single entry for gaur: 'Khting'. The term 'Khting Vor' should be separated from the taxonomic debate pertaining to *P. spiralis*. If a common name must be applied to a possibly non-existent creature, I propose 'Sat Min Chbah' or 'Sat Sum Klum'.

There should be no confusion on kouprey/kouprou. I agree with Coolidge (1940) that both kouprey and kouprou are names used only for *Bos sauveli*. My hill-tribe trackers, depending on the settlement, used them interchangeably. Hoer states (my translation) that the, 'veterinarian Sauvel gave his name to this bovid, found only in Cambodia which, in certain regions of the Kingdom, is also called Kouprou'. Coolidge carried on an extensive correspondence with Urbain, who also noted both names (Urbain, 1937).

Timm & Brandt (2001) state that they 'suspect that the frontlets were boiled to remove the horns and the tips of the bony horn cores were sawn or broken off at that time to drain out the marrow as well as to remove the cartilaginous tip. This was a common practice of hunters of that era'. This is not correct in my experience, nor according to my 'chasse et faune' book collection. I would like to know their source. When I collected in the late 1950s and early 1960s, the whole head would be scraped clean, then buried for a week or more, and insect larvae would do the rest. It emerged with all detritus removed, including the marrow, and after application of a local antiseptic was odour free. The rare trophy-quality specimen was mounted, and other specimens were sent to the forestry college for study and instruction. The horn sheaths were never removed. This practice was common among all hunters of my acquaintance, including Hoer and Dumas. Monestrol (1925) writes of a related alternative method: after the frontlet was removed it was scraped clean, left in the sun for a period, then rinsed and wiped clean. Then it was turned horn-points-down and a mixture containing formalin was poured into the bony horn 'honeycomb'. After a while the horns were rinsed out, with no odour remaining, and with the marrow detritus removed. At no point was the sheath removed.

Timm & Brandt (2001: 163–164) speculate that the kouprey and *P. spiralis* may have been confused with one another by hunters and scientists since 1930, that the Defosses (also spelt Dufosse and Desfosse) (hunting guides) may have associated this odd animal with the name kouprey, and that thus, 'the kouprey referred to in their hunting circular may have been *P. spiralis*. It is also possible that additional specimens of *P. spiralis* exist that were taken by other game hunters led by the Defosses to this region'. This is tortured conjecture;

Defosse accurately described the real kouprey on page 9 of the circular, accompanied by a photograph of a kouprey horn set. The Defosses had an excellent command of idiomatic English; their hunting circular was sent to Coolidge in 1930 and is referenced in Coolidge's (1940) landmark study of a genuine new bovid, the kouprey.

In Timm & Brandt (2001) the issue that has provoked the most intense debate is how and where the Kansas Natural History Museum specimens were collected. Hoffmann (1986) quotes Hall, who quotes Sutton Jr, that they 'probably came from animals shot for meat and/or bait'. Timm & Brandt leave out that important 'probably'. On locality, the labels now read 'Cambodia, about 100 miles north-east of Saigon at Suoi Kiet near Phan Thiet'. Before hunting, the Suttons spent a week in Cambodia in Phnom Penh and at Angkor. The Defosses accompanied them and, 'Louis [son] went back to Annam to prepare the camps and purchase buffalo bait' (Sutton & Sutton, 1930: 236). In 1905 the French built a railroad between Saigon and Phan Thiet passing through Suoi Kiet where a station was constructed. The area soon attracted a small French colony because of the climate and good hunting in the dense bamboo forests.¹ Defosse made his residence there. Thus it is not at all improbable that the specimens were purchased in Cambodia and/or at Suoi Kiet. Therefore, Timm & Brandt do not know how they were acquired. Sutton Jr was 85 when he reconfirmed the date and locality to Hoffmann (1986). For the 'collected' purists, note that on the 1929 Field Museum expedition, Coolidge included in his 4000 specimens, 1000 'collected' bird specimens purchased from a wildlife dealer for \$1563 gold dollars.

It was not at all impossible to hand craft fake horn sets in the 1920s. Vittoz (1933) described how horn sheaths were softened. Artisans of that time might have crafted horn sets from *Bos taurus* as a weekend whimsy. Seveau (2001) includes four specimens brought by a cotton planter from Indochina in 1925. DNA analysis of the frontal [Hassanin *et al.*, 2001] and dissection of the keratin sheath [Thomas *et al.*, 2001], show the specimens to be manipulated *Bos taurus*.

A significant article on the historical context of *P. spiralis* has been written by Macdonald & Yang (1997). They refer to a Chinese source (San Cai Tu Hui, 1607) which described a fabled goat-like ungulate in south China (later Indochina) that hung by its horns from trees, and was eaten by people to avoid snake attack. There is a similar belief in India about a goat known by its Pushtu name of markhor (snake-eater), and indeed the horns of the Astor race of the markhor could be the prototype from which fakes are made. Add the Hindu-Khmer creation myth with the centrality of the serpent and we arrive at a clearer understanding of *P. spiralis* folklore. However, as described in the Chinese source, the probable real animals from which this myth originated was either a saiga or serow, or

perhaps a larger species such as a bharal or markhor, and was not *P. spiralis* or any species of *Bos*.

The Kansas Natural History Museum specimens are being used as critical evidence in a scientific inquiry. The null hypothesis of the purchase of faked specimens rather than collection of a new genus of mammal must be assumed unless falsified. Thus the onus for proof is on the believers in their authenticity.

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R. M.

FURTHER INFORMATION ON THE UNLIKELY EXISTENCE OF THE BOVID: *PSEUDONOVIBOS SPIRALIS*

I gathered the following information through long and hard field studies that have led me to the belief that the bovid with spiral-shaped horns was only a myth, the origin of which remains unclear, and that this animal has only existed in people's imagination. The following information will add to the report that has been already published by Thomas, Seveau & Hassanin (2001) and which showed through different analyses that all the trophies in my possession (seven trophies + two solitary horns = 16 horns) had been transformed by hand from horns of domestic cattle (ox or buffalo).

Today, as far as I know, there are at least 70 horns of *P. spiralis*, two-thirds of which are attached in pairs on a bony frontlet to provide trophies. Six of the trophies were collected in Indochina before 1930. I have been able to see most of the reported horns in pictures or on video, except the specimen stored in Russia. All had visible signs revealing their transformation as follows:

- (1) The thickness of the bottom of the horns is generally too thin (except at the bottom of some horns carved from buffalo horn).
- (2) The deterioration of the keratin layers and the fractures generally observed at the bottom of the horn torsion reveal tensions caused by a modification through a source of heat and maintaining the natural shape of the horn sheath.
- (3) The heads of the growth rings show that some of the horn has become splintered proving that the structure of the keratin layers was unnaturally carved. Not to mention the perfectly regular spacing between the growth rings on all the horns studied; such regular

¹ On the maps it is tourist itinerary 9.

patterns of growth can hardly ever be observed in a wild animal.

The putative *P. spiralis* has been equated by some authors with the Cambodian vernacular names Khting Pos (snake ox) and Khting Vor (spiral horned ox). The oldest reference of the Khting Pos dates back to 1870 (Janneau, 1870). This author also referred to it as the Khting Châ and for the first time, the kouprey. Aymonier (1883) gave details of the behaviour of the Khting Pos and the popular beliefs relating to the animal, and many authors subsequently used this information. But the morphological descriptions are often unclear and contradictory, and it should be noted that no one mentioned the particular growth rings on Khting Pô's horns.

According to Dufossé (1930), who spent more than 20 years in Cambodia, the name 'Khting Pô' is referred to as the gaur by the people of Cambodia. In 1925, Bordeneuve (1925) reported that the people of southern China referred to the gaur as the Nguu-Xa, that is to say 'snake ox'. There is no mention of the 'Khting Vor' either in the French colonial literature or in local dictionaries. The dozens of testimonies I gathered on the spot do not support any claim that the animal exists or ever existed. Even if the reasons for the faking of the horns are still unknown, the technique used for this work has always been known in South-east Asia. Fake rhinoceros horns, knife handles, combs, music instruments, etc., were commonly made only a few decades ago. Cambodian and Vietnamese fakers probably chose horns of domestic cattle or domestic water buffalo that were long enough to construct horns of *P. spiralis*. The surface of the horn was filed off to make the growth rings. The torsion was made by using a source of heat. According to my own experiences, keratin is completely softened at a temperature of about 120 °C. The spiral shape was produced with a special instrument while the horn was cooling, while it is possible that the final polishing was made with the leaf of a plant called 'snay' (*moracéa*) (M.-A. Martin, pers. comm.) in Cambodia and with limestone powder coming from a cuttlebone or carbonized bivalve.

Postscript

On 22 June 2001, during a short trip to Germany, I had the chance to see the type series of *Pseudonovibos spiralis*, which is held in the collection of the Staatliche Naturhistorische Sammlungen Dresden, Museum für Tierkunde, under the curation of Dr Alfred Feiler and his successor Dr Thomas Ziegler.

The pair of horns that has been allocated as the holotype of the species *P. spiralis* displays numerous superficial, sinusoidal lines along the horns, which point to the artificial creation of the rings or annulations which are the chief characteristic of this so-called new species of bovid. In fact, this pair of horns probably originated from a water buffalo *Bubalus bubalis*, as

indicated by the dark brown colour of the horn and the cross section of the internal mould that has been obtained by Dr Feiler and Dr Ziegler who are continuing to carry out detailed microstructural and molecular analyses of the specimens, and to whom my thanks are due for their kind help.

All the material I have seen presents different and inconsistent characters which clearly show that the horns have been subject to human modification, and I therefore suggest that the name *P. spiralis* should be made a synonym of *B. bubalis*.

A. S.

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