ISSN NO. 2320-5407

Journal homepage:http://www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH

RESEARCH ARTICLE

ANGIOGRAPHY OF THE FORE DIGITS IN EGYPTIAN WATER BUFFALO (BOSBUBALIS)

Anwar. A. El-Shafey[1]; Samer.M.Daghash[2] and Adel. M. Al-Akraa[3]

1.Department of Anatomy and Embryology, Faculty of Veterinary Medicine, Benha University, Egypt.
2. Department of Anatomy and Embryology, Faculty of Veterinary Medicine, Cairo University, Egypt.
3. Department of Surgery, Faculty of Veterinary Medicine, Benha University, Egypt.

Manuscript Info

Manuscript History:

Received: 15 July 2015
Final Accepted: 26 August 2015
Published Online: September 2015

Key words:

Angiography, Digit, Buffalo.

Corresponding Author

Adel. M. Al-Akraa

Abstract

The present work was carried out on the thoracic limbs of twelve apparently healthy buffaloes of different sex and age. The dorsal and palmar metacarpal as well as the cranial superficial antibrachial arteries were traced just distal to the carpal joint and catheterized with 16-gauge angiocatheter needle. Arteriography was carried out by 15 ml contrast medium injected through the catheter in each vessel. Radiographs were obtained in dorso-palmar,palmo-dorsal, medial and lateral views. The results of the present study were performed on four angiographic images of the buffalo metacarpal and digital arteries. Fine details of blood vessel patterns were recorded and the arterial anastomoses were clarified demonstrated and labeled. The purpose of the present study was to provide a detailed view of normal pattern of the arterial blood supply of the foot and digits of buffalo which would serve as an initial reference in order to be able to asses a diseased condition of digits and claw in this species, and finally providing a diagnostic basis by the aid of angiograph in such economically important animal, concerning meat and milk production.

INTRODUCTION

The buffalo is considered a very important meat and fat rich milk producing animal in Egypt. The aggregate share of buffalo milk is about 81% of total milk production in Egypt (SolimanandSadek, 2004).

Digital affections in cattle occur frequently and comprise the majority of limb disorders, in which the vascular involvement is often under assessed. Several conditions, including acute laminitis are known to perpetuate significant alterations in the vascular dynamic of the digit. The early signs of vascular involvement may be purely subjective and often go unnoticed by the veterinarian (Manohar*et al*., 1973).

Angiography offers simple and precise mean of diagnosing and assessing vascular involvement, as the evaluation of size, number, distribution, wall integrity, and luminal diameter of vessels. It is used for the diagnosis of pathological conditions such as traumatic ischemia, thrombosis, congenital malformation, bone pathology and other conditions. Knowledge of normal angiographic appearance of a structure serves the basis for comparison. This technique has been used for normal digit in cattle (Manohar*et al*., 1973; Prenticet and Wyn-Jones, 1973; Gogoi*et al*.,1982;Singh*et al*., 1994), goat (Burns and Cornell, 1981; Dehghani*et al*., 2007), horse (Ackerman *et al*., 1975 ;Scott *et al*., 1978; Rosenstein *et al*., 2000; Brunner, *et al*., 2008), donkey (Alves*et al*., 2009) and camel (Ramadan, 1994 ; Al-AniFalah, 2004 ;Dehghani*et al*., 2011).

The present study aimed to provide a detailed view of normal pattern of blood circulation of the fore digits of the Egyptian water buffalo to be used for comparison with diseased digits and claws in this species.

MATERIALS AND METHODS:

The present work was carried out on the thoracic limbs of twelve apparently healthy buffaloes (of different sex and their age, 2-7 years old). The specimens were collected immediately after slaughtering by disarticulating the carpometacarpal joint. The specimens were transferred to the laboratory in ice cold water bags.

The dorsal, palmarmetacarpal and cranial superficial antibrachial arteries were dissected free just distal to the carpal joint and subsequently catheterized with 16-gauge angiocatheter needle. These were flushed with heparinised saline solution (500 IU/ liter).The dorso-lateral metacarpal vein was isolated, to assure free venous outflow frequently until clear saline solution was drained out of the arteries. A rubber tourniquet was placed around the proximal third of metacarpus.Arteriography was carried out by 15ml contrast medium (Urographine 30% " sodiumdiatrizoate 40mg/ml and meglumindiatrizoate 260mg/ml in aqueous solution, Australian") was injected through the catheter in each vessel. The veins and arteries were kept occluded by hemostats. Radiographs were obtained in dorso-palmar,palmo-dorsal, medial and lateral views by simply HP radiographic machine(KVp; 55, mAs; 20, ms; 16 sec) at Department of Surgery, Faculty of Veterinary Medicine, Benha University and large cassettes were recommended.

The radiographs were processed manually. Then they were evaluated and studied over the radiographic illuminator and fine details of blood vessel patterns were recorded. All arterial anastomoses were noticed and labeled with theaid of multiple references (Getty, 1975; Nickel et al., 1996; Schaller, 2007), together with (NominaAnatomicaVeterinaria, 2012).

RESULTS:

The results of the present study were performed on four angiographic images of the buffalo metacarpus and digits arteries. The main arterial blood supply of the buffalo digit constitutes the dorsal and palmar digital arteries.

The dorsal metacarpal arteryIII (Fig.1/1) descends in the dorsal longitudinal groove of the large metacarpal bone (fused 3rd and 4th metacarpal bones), and continues over the dorsal aspect of the fetlock joint as common dorsal digital artery III(Fig.1/2). After that this vessel courses in the inter digital space and anastomoses with the inter digital arteryIII (Fig.1/3).The dorsal metacarpal arteryIII connected with the palmar metacarpal arteries via sending the distal perforating branch (Fig.1/4) which is joined the deep palmar arch through the distal metacarpal canal. The two axial dorsal proper digital arteries III (Fig.1/5) and IV (Fig.1/6) spring from the common dorsal digital artery III near the middle of the proximal phalanx.

The cranial superficial antibrachial artery (Fig.1/7) courses on the dorso-medial face of metacarpal bone in the lower third of the metacarpus giving rise to the equally delicate branches, the common dorsal digital artery II (Fig.1/8) and III. The former continues as abaxial dorsal proper digital artery III (Fig.1/9), while the latter vessel joins the dorsal metacarpal arteryIII. Dorsal common digital artery IV (Fig.1/10) is a very thin artery that courses on the dorso-lateral aspect of metacarpal bone and continues distally as abaxial Proper dorsal digital artery IV (Fig.1/11).

The palmar metacarpal arteries II-IV (Fig.2/ 1, 2, 3) have a common termination into the palmar common digital arteries and are frequently interconnected. The palmar and dorsal metacarpal arteries are connected distally by the distal perforating branch (Fig.2/4). The palmar common digital arteries II-IV (Fig.2/5, 6, 7) arise directly from the superficial palmar arch (Fig.2/8)

The palmar common digital artery III(Fig.2/6)courses on the posterior aspect of the fetlock joint and passes into the inter digital space. Near the middle of the proximal phalanx it gives off two palmar branches of proximal phalanx (Fig.2/9) which join abaxial palmar proper digital arteries. The parent vessel then communicates with dorsal

common digital artery III(Fig.2/10)via the inter digital artery (Fig.2/11) and divides into axial palmar proper digital arteries III and IV (Fig.2/12, 13). Each artery gives off dorsal and palmar branches of middle phalanx (Fig.2/14, 15). The two arteries descend along the inter digital surfaces of the chief digits and give the palmar branch of distal phalanx (Fig.2/16) that pass through the foramina at the proximal part of the inter digital surfaces of the distal phalanges, entering the latter and anastomose with the abaxial palmar proper digital arteries III and IV (Fig.2/17, 18) forming the terminal arch (Fig.2/19). From the terminal arch numerous branches pass through the bone to the dorsal surface and ramify in the corium of the wall and sole of the claw. A number of branches emerge through the foramina at the distal border, where they anastomose with each other in arciform fashion forming a uniform network of marginal capillaries**.**

The Palmar common digital artery II (Fig.3/1)arises from the Superficial palmar branch of radial artery(Fig.3/2) and the superficial palmar arch (Fig.3/3), and descends on the medial side of the digit divides distally into palmar proper digital artery II (Fig.3/4) and III (Fig.3/5). It descends along the abaxial side of third digit and, near the middle of the proximal phalanx receives the palmar branch of the proximal phalanx (Fig.3/6) from the palmar common digital artery III (Fig.3/7) where the dorsal branch of proximal phalanx (Fig.3/8) arises to supply the dorsal abaxial surface of the third digit. The palmar proper digital artery II, terminates at the bulb of claw by anastomosing with the corresponding proper digital artery. It gives off a branch to the dew claw and continues downward offering off many branches to the dorsal part of the claw wall as well as leading numerous branches to caudal part of the claw and sole.

The Palmar common digital artery IV (Fig.4/1) arises from the superficial palmar arch (Fig.4/2), passes down on the lateral side of thedigit and near the fifth digit then divides distally into palmar proper digital artery IV (Fig.4/3) and V (Fig.4/4). palmar proper digital artery IV receive the palmar branch of the proximal phalanx (Fig.4/5) from the palmar common digital artery III (Fig.4/6) where the dorsal branch of proximal phalanx (Fig.4/7) arises to supply the dorsal abaxial surface of the third digit. The palmarproper digital artery IV terminates in a similar distribution to the palmar proper digital artery II.

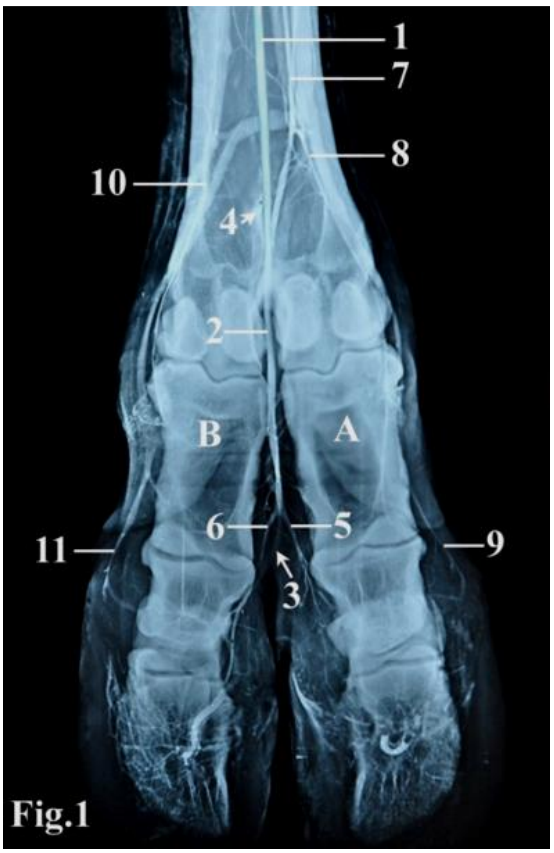

Fig. 1: Angiography from dorso-palmar view of the distal region of the right forelimb of a buffalo showing the arterial pattern of the fore digits. A)Third digit. B) Forth digit. 1) Dorsal metacarpal artery III. 2) Common dorsal digital artery III. 3)Inter digital artery. 4) Distal perforating branch III. 5) Axial dorsal proper digital artery III. 6) Axial dorsal proper digital artery IV. 7) Cranial superficial antibrachial artery. 8) Common dorsal digital artery II. 9) Abaxialdorsal proper digital artery III. 10) Common dorsal digital artery IV. 11) Abaxialdorsal proper digital artery IV.

Fig. 2: Angiography from palmo-dorsal view of the distal region of the right forelimb of a buffalo showing the arterial pattern of the fore digits. A)Third digit. B) Forth digit. 1) Palmar metacarpal artery II. 2) Palmar metacarpal artery III. 3) Palmar metacarpal artery IV.4) Distal perforating branch.5) Palmar common digital artery II. 6) Palmar common digital artery III. 7) Palmar common digital artery IV. 8) Superficial palmar arch. 9) Palmar branch of proximal phalanx. 10) Dorsal common digital artery III. 11) Interdigital artery. 12) Axial palmar proper digital artery III. 13) Axial palmar proper digital artery IV. 14) Dorsal branch of middle phalanx. 15) Palmar branch of middle phalanx. 16) Palmar branch of distal phalanx. 17) Abaxial palmar proper digital artery III. 18) Abaxial palmar proper digital artery IV. 19) Terminal arch.

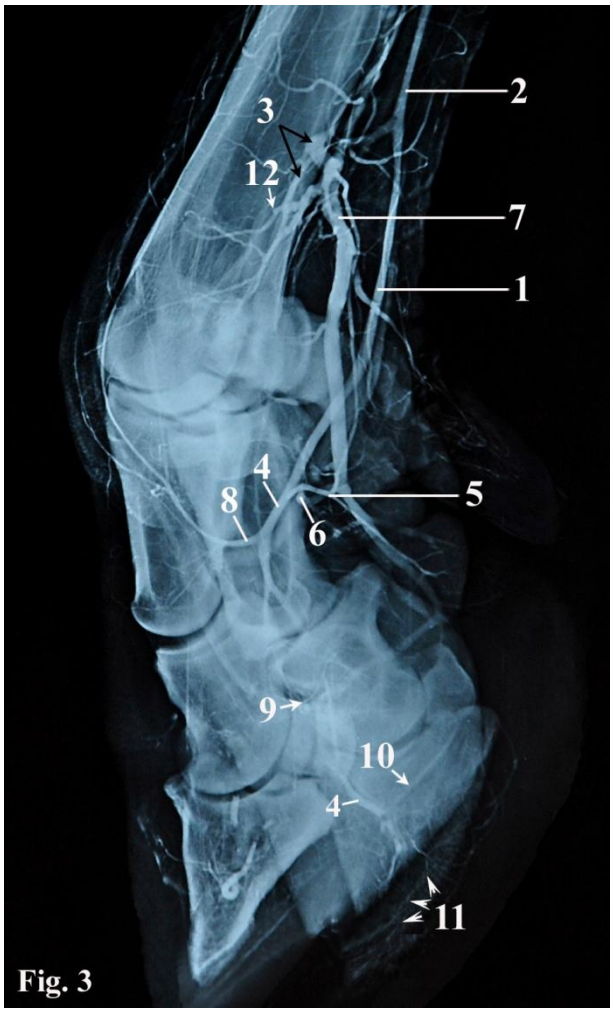

Fig. 3: Angiography from Medio-lateral view of the distal region of the right forelimb of a buffalo showing the arterial pattern of the fore digits. 1) Palmar common digital artery II. 2) Superficial palmar branch of radial artery. 3) Superficial palmar arch. 4) Axial palmar proper digital artery II. 5) Abaxial palmar proper digital artery III. 6) Palmar branch of proximal phalanx. 7) Palmar common digital artery III. 8) Dorsal branch of proximal phalanx. 9) Dorsal branch of middle phalanx. 10) Branch of Torus ungulae. 11) Terminal arch. 12) Distal perforating branch.

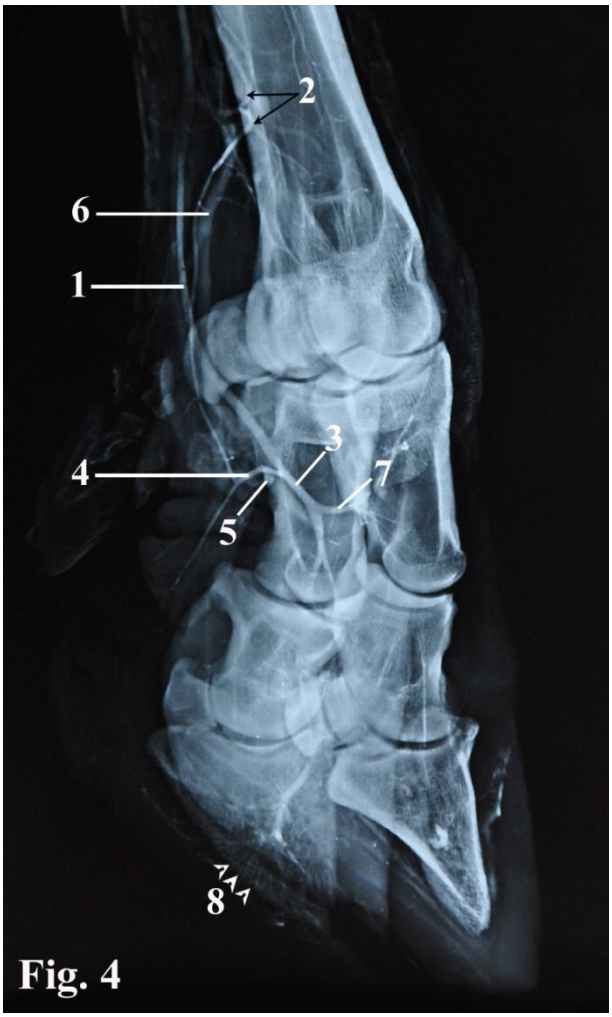

Fig. 4: Angiography from Latero-medial view of the distal region of the right forelimb of a buffalo showing the arterial pattern of the fore digits.1) Palmar common digital artery IV. 2) Superficial palmar arch. 3) Abaxial palmar proper digital artery IV. 4) Axial palmar proper digital artery V. 5) Palmar branch of proximal phalanx.6)Palmar common digital artery III.7) Dorsal branch of proximal phalanx.8) Terminal arch.

DISCUSION:

The present study served as an initial reference of angiography of digital circulation of buffalo and provides acceptable details of the digital vasculature that in accordance with some authors (Manohar*et al*., 1973;Prenticet and Wyn-Jones, 1973;Gogoi*et al.*,1982; Singh *et al*., 1994)in cattle, (Burns and Cornell, 1981 ; Dehghani*et al*., 2007) in goat, (Ackerman *et al*., 1975 ;Scott *et al*., 1978; Rosenstein et al., 2000) in horse, (Alves*et al*., 2009) in donkey and (Ramadan, 1994 ; Al-AniFalah, 2004 ; Dehghani*et al*., 2011) in camel.

Knowledge of normal angiographic appearance of digital vasculature is essential for understanding the pathophysiology of the locomotors disorder. Angiography demonstrating various spontaneously occurring vascular diseases such as arterial embolism, arteriosclerosis and various types of vascular shunts. The recurrence of clinicalvascular disease prompted this study of angiography in the bovine foot (Manohar*et al*., 1973).The most prominent arteriographic abnormalities associated with chronic laminitis in cattle included dilation, tortuous and irregular course, and constriction of the claw artery at the exit of the pedal bone. The primary branches of the claw artery were frequently constricted or dilated; constrictions were predominantly seen in the toe area (Boosmanl*et al*., 1989).

The angiographic findings of the buffalo digit in the present study was also found to be following similar pattern as in the cattle reported earlier by(Gogoi*et al.*,1982;Manohar*et al*., 1973;Prenticet and Wyn-Jones, 1973; Singh *et al*., 1994).The blood vessels that seen in cattle could be detected very well in the angiographic images of the buffalo.

The present study revealed that the arterial blood supply of the buffalo digit constitutes the dorsal and palmar digital arteries. The cranial superficial antibrachial artery which courses on the dorso-medial face of metacarpal bone, in the distal half of the metacarpus was not demonstrated in the arteriographical findings of the goatdigit (Burns and Cornell, 1981 ;Dehghani*et al*., 2007),and camel (Ramadan, 1994 ; Al-AniFalah, 2004 ; Dehghani*et al*., 2011, elsewhere they found similar vascular pattern of goat and cameldigits with that of buffalo digital circular pattern .

The terminal arch sends numerous branches pass through the distal phalanx to the dorsal surface and ramify in the corium of the wall and sole of the claw. A number of branches emerge through the foramina at the distal border, where they anastomose with each other in arciform fashion forming a uniform network of marginal capillaries. similar to that observed by(Ackerman *et al*., 1975 ;Scott *et al*., 1978; Rosenstein *et al*., 2000; Brunner, *et al*., 2008), in equine,(Alves*etal*., 2009) in donkey and (Ramadan, 1994 ; Al-AniFalah, 2004 ; Dehghani*et al*., 2011), in camel.

Conclusion and Clinical Relevance:

The authors would be concluded that the arterial blood supply of digits was derived from the dorsal and palmar metacarpal as well as the cranial superficial antibrachial arteries which configuration the same pattern in horse, cattle, camel and goat. The angiographic study should be performed in any diseased conditions, congenital abnormalities or surgical affections of foot and digits of buffalo to assist the blood vasculature through observation of filling defect of contrast media.

Contribution of each author

All authors are equally contributed

Acknowledgment:

The authors would like to thank Benha University site (www.bu.edu.eg) and **Prof. Dr. H. Bahgat,**Department of Anatomy and Embryology, Faculty of Veterinary Medicine, Benha University, Egypt, for his help and support.

REFERENCES

1. **Ackerman, N., Garner, H., Coffman, J.R. and Clement, J.W.(1975):** Angiographic appearance of the normal equine foot and alterations in chronic laminitis. Journal of American Veterinary Medical Association 166:58-62.
2. **Al-AniFalah, K. (2004):** Camel Management and Diseases. 1st Ed. Al-Sharq Printing Press, pp 317-325.
3. **Alves, F.R., Guerra, E.T., Junior,A.A., Machado, F.C., Aranha, R.M., Ambroso, C.E., Mariana, A.N. and Miglino, M.A. (2009):**Angiographic aspect of the distal forelimb in donkeys (Equusasinus) used for animal traction. Biotemas, 22 (4): 163-167.
4. **Boosmanl, R Nemeth, F., Gruys, E. and Klarenbeekl,A. (1989):**Arteriographical and pathological changes in chronic laminitis in dairy cattle. The Veterinary Quarterly, Vol. 11, No. 3.
5. **Brunner, C.H.M., Martins, M.F.M. and Bovino, E.E. (2008):** In vivo angiography for evaluation of equine foot vasculature. Ciência Rural, Santa Maria, v.38, n.1, p.116-123.
6. **Burns, J. and Cornell, C. (1981):** Angiography of the caprine digit. Veterinary Radiology 22:174-176.
7. **Dehghani, S.N.,Abbasi, S. and Tadjalli, M. (2007):** Arteriographical Evaluation of Normal Digit and Hoof in Goat. Iranian Journal of Veterinary Surgery (IJVS) vol. 2 No. 4, p 43-48.
8. **Dehghani, S.N., Kohkiloyehzadeh, M. and Sazmand, A. (2011):** Digital angiography of camel foot. Journal of Camel Practice and Research Vol18 No1, p119-121.
9. **Getty, R. (1975):** The Anatomy of the Domestic Animals, 5th edn, Vol. 1. Philadelphia, London, Toronto: WB SaundersCo., pp. 993–1002, 1141–1147.
10. **Gogoi, S., Nigam, J. and Singh, A. (1982):** Angiographic evaluation of bovine foot abnormalities. Veterinary

Radiology' 22: 171-174.

11. **Manohar, M., Kumar, R., Bhargava, A.K. and Tyagi, R.P.S. (1973):** Angiographic Studies of the Bovine (Bubalisbubalis) Foot. Veterinary Radiology, 14: 81–86. doi: 10.1111/j.1740-8261.1973.tb00658.x.
12. **Nickel, R., Schummer,A. andSeiferle, E. (1996):** The Anatomy of Domestic Animals, Vol. 2. Oxford: Blackwell Science, pp. 69–71, 428–432, 191–197.
13. **NominaAnatomicaVeterinaria (2012):** Prepared by the international committee on Veterinary Gross Anatomical Nomenclature (I.C.V.G.A.N) and authorized by the General Assembly of the World Association of veterinary Anatomists (W.A.V.A.), Knoxville, TN (USA). 5th edition – revised version. Published by the Editorial Committee, Hannover, Columbia, Gent, and Sapporo.
14. **Prenticet, D. and Wyn-Jones, G. (1973):** A technique for angiography of the bovine foot. Research in Veterinary Science 14:86-90.
15. **Ramadan, R.O. (1994):** Surgery and Radiology of the Dromedary Camel. Al-Jawad printing press. Saudi Arabia, pp 341.
16. **Rosenstein, D.S.1, Bowker, R.M. andBartlett, P.C. (2000):** Digital angiography of the feet of horses. Am J Vet Res. ;61(3):255-9.
17. **Schaller,O. (2007):** Illustrated Veterinary Anatomical Nomenclature. 2nd Ed. Stuttgart, EnkeVerlag.
18. **Scott, F., Sander, G. and Shires, M. (1978):** Angiography as a diagnostic technique in the equine. Journal of Equine Medicine and Surgery 2:270-278.
19. **Singh, S., Ward, W. and Murray, R. (1994):** An angiographic evaluation of vascular changes in sole lesions in the hooves of cattle. British Veterinary Journal 150:41-52.
20. **Soliman, I. andSadek, H. (2004):** Impacts of productive and reproductiveperformances on investment efficiency of buffaloenterprises in Egypt. Proceedings of 7th World Buffalo Congress, Manila, Philippines, 1:212-7.