

HELMINTHOLOGIA, 52, 4: 303 - 309, 2015

Abattoir survey on extra-cerebral coenurosis in goats

R. K. SCHUSTER^{1*}, S. SIVAKUMAR¹, T. WIECKOWSKY², J. REICZIGEL³

¹Central Veterinary Research Laboratory, PO Box 597, Dubai, U.A.E., *E-mail: moniezia@zedat.fu-berlin.de; ²Nad Al Sheba Palace Veterinary Clinic, Dubai, U.A.E.; ³Szent István University H-1078, Budapest, István u. 2, Hungary

Article info

Received February 17, 2015
Accepted April 15, 2015

Summary

Out of 19,046 goats aged between 5 and 6 month and slaughtered at an abattoir in Dubai between September 2012 and March 2014, 57 carcasses were objected at meat inspection due to the presence of bladder worms of the *coenurus* type. The majority showed single cysts that were cut out but 10 carcasses had to be discharged due to the presence of multiple cysts and with a maximum number of 41 coenuri. In the majority of carcasses, cysts were located in the legs (n=45) followed by abdominal muscles (n=16), diaphragm (n=14) and shoulder (n=13). Loin, rack, renal fat, heart, neck, masseter were other cyst locations. The size of the detected parasitic cysts ranged from 0.7 ml to 90 ml. The maximum number of 1,102 scolices was counted in an 86 ml coenurus found in the leg of a goat. *Cysticercus tenuicollis* was another cestode larval stage found in livers of 302 goats. A mixed infection with both parasites was detected in 35 carcasses.

Keywords: extra-cerebral coenurosis; goat; United Arab Emirates

Introduction

The parasitic nature of gid caused by *Coenurus cerebralis*, the larval form of the cestode *Multiceps multiceps* was recognised by Goeze (1780) and Leske (1780) for the first time by describing multiple buds with four suckers and a double circle of hooks at the inner surface of the bladder removed from sheep brains. Gaiger (1907) examined coenuri in the connective tissues of two goats in India. Wrongly, he determined his findings as larval stage of *Multiceps serialis*. A further case of coenurosis in intra-muscular connective tissues of a goat in India was detected two years later (Dey, 1909). Hall (1916) decided that these cysts differ from those of *M. serialis* and described a new species, naming it *M. gaigeri* in honour to Dr. Gaiger. In the following time till recent years numerous cases of extra-cerebral coenurosis in goats have been reported (Table 1). First such cases in goats in the UAE were detected in 2008 (Schuster *et al.*, 2010).

Intra-muscular and subcutaneous coenuri were described also in sheep in all four Central Asian Republics under the name of *C. skrjabini* (Bondareva, 1963) and were seen recently in sheep carcasses in the UAE (Christodouloupoulos *et al.*, 2013).

Since scolices of extra-cerebral bladder worms *Coenurus gaigeri* and *C. skrjabini* showed the same morphological features as *C. cerebralis* including shape, numbers and measurements of rostellar hooks Verster (1969) and Loos-Frank (2000) doubt their validity and put them as synonyms. Despite striking differences in the morphology of the larval stage both authors transferred *Multiceps* species into the genus *Taenia*. The aim of this paper is to describe the location of extra-cerebral coenuri and their size in goat carcasses.

Materials and Methods

Carcasses of clinically healthy young goats (5 to 6 months of age) and their livers were examined during routine meat inspection at an abattoir in Dubai between August 2012 and March 2014. The animals were obtained from various cattle markets in the UAE and it is believed that their origin was Iran, Oman and East Africa.

At the routine meat inspection carcasses and livers with macroscopically visible alterations (maggots and metacestodes) were objected and suspicious materials were sent for determination to the Central Veterinary Research Laboratory in Dubai.

Nearly half of the intramuscular cysts were cut or ruptured during

Table 1. Occurrence of coenurosis in goats in different countries. (? heads were not examined)

Country	Place/region	Number of goats examined	Extra-cerebral coenuri		Cerebral coenuri	Reference
			Number of affected animals	Location		
Bangladesh	-	430	5	diaphragm, abd. muscles, leg	31	Alim et al. (2002)
China	Fujian	(exp. Infection)	12	"muscles"	10	Yan &Wang (1992)
Egypt	Sharkia	10	0	-	10	Desouky et al. (2011)
Ethiopia	Debre Zeit	974	0	-	68	Jibat et al. (2008)
India	Chattisgarh	(case report)	2	masseter	?	Gosh et al. (2005)
India	Uttar Pradesh	(case report)	1	leg	?	Madhu et al. (2014)
India	Bidar	(case report)	25	neck, shoulder, abd. muscles, leg	0	Shivapraksh & Thimma (2009)
India	Murshibadabad	85698	207	"muscles"	?	Bandopadhyaya (1991)
India	Jaipur	(case report)	1	liver	1	Godara et al. (2011)
India	Assam	(case report)	5	orbita, muscles	in 1	Islam et al. (2006)
Iran	Shiraz	52	4	neck, shoulder, loin	?	Moghaddar (2007)
Iran	Sharekord	(case report)	0	-	1	Nourani & Kheirabadi (2009)
Iran	Tabriz	510	0	-	3	Javadi et al. (2010)
Iran	Kerman	25739	23	leg, shoulder, neck, abd. muscles	2	Kheirandish et al. (2012)
Mosambique	Tete	130	8	leg, neck, loin	18	Vink et al. (1998)
Mosambique	Tete	149	15	"muscles"	12	Afonso et al. (2011)
Mosambique	Tete	57 (exp. Infected)	45	"muscles"	4	Afonso et al. (2011)
Oman	-	(case report)	1	leg, neck, loin, diaphragm	no	El Sinnari et al. (1999)
Sudan	Khartoum	(case report)	0	-	3	Abbas (1978)
Sudan	Omdurman	(case report)	1	generalised	no	Hago & Abu-Samara (1980)
Sudan	Khartoum	(case report)	1	leg, neck	0	Ramadan et al. (1973)
Turkey	Antalya	(case report)	1	loin	?	Oge et al. (2012)
UAE	Dubai	17,223	48	Leg, loin, diaphragm	?	Schuster et al. (2010)
UAE	Dubai	19,046	57	Leg, abd. muscles, diaphragm	?	This paper



Fig. 1. Opened coenurus with multiple scolices in 11 clusters fixes to the inner surface of the cyst

meat inspection. But 112 metacestodes arrived intact and were cleaned from surrounding muscle tissues by scissors. Their volume was determined by a method after Elias and Hyde (1980) based on the Archimedes' principle: The volume of the body plunged into the water equals the volume of the displaced water and can be read directly from the scale since 1 g of water equals 1 ml. For this, metacestodes were put into water filled measuring cylinders of 100 or 200 ml depending on the size of the cysts. The bladder was then transferred in a Petri dish with PBS and opened by scissors. The arrangement and the number of protocolizes were counted under a stereoscopic microscope. Cysts were grouped according to their volumina into 6 categories (<5.0 ml, 5.0 – 9.9 ml, 10.0 – 14.9 ml, 15.0 – 19.9 ml, 20 – 29.9 ml and >30 ml) and the average number of protoscolices per category was compared by one way ANOVA. To study the size of the rostellar hooks single opened cysts were exposed for 20 min to 40 °C warm PBS diluted dog bile. Evaginated scolices were cut behind the suckers and placed on a slide in a drop of alcohol/glycerin (10/1) for clearing and covered with a cover slip. Histological sections from cysts were made to determine the nature of these tissue parasites.

After determining metacestodes attached to the livers, gall bladder and major bile ducts were opened and examined for the presence of liver flukes.

To test the association between coenuri and *Cysticercus tenuicollis* Fisher's exact test was applied.

Results

Out of 19,046 goat carcasses slaughtered a total of 57 were objected at meat inspection due to the presence of intra-muscular cysts of the coenurus type characterized by multiple invaginated protoscolices fixed in clusters to the inner surface of the bladder (Fig 1). Most of the infected carcasses were made suitable for con-

sumption after single cysts were cut out. The number of carcasses with one to four cysts was 31, 12, 2 and 2, respectively. Due to multiple occurrences of cysts 10 carcasses had to be discharged completely (Fig 2). The maximum number of coenuri counted in



Fig. 2. Generalised coenurosis in a goat carcass. Coenuri are situated in legs, abdominal muscles, diaphragm, heart and renal fat

Table 2. Location of coenuri in goat carcasses according to meat cuts of goat carcasses.
(*only one head was presented)

Location	Number of	
	animals affected	cysts isolated
neck	2	3
brest	3	5
rack	7	21
left shoulder	7	19
right shoulder	6	11
loin	9	22
left leg	28	59
right leg	17	43
diaphragm	14	30
abdominal muscles	16	22
heart	3	7
masseter*	1	1
renal fat	4	6
total:	249	

one carcass amounted to 41. In one carcass, all 25 muscle cysts were in various stages of caseous degeneration. No intact scolices were present but a large number of rostellar hooks were seen in smears. Goat heads were usually discharged and were not available for examination. However, one head showed an unnormal swelling of chicken egg size on the right masseter caused by a coenurus. No coenuri were found in the brain of this animal.

The total number of coenuri found in the 57 carcasses was 249. Legs, diaphragm and abdominal muscles were preferred location sites (Table 2). The volume of the cysts varied between 0.7 and 90 ml. The largest cysts (>30 ml) were located under the surface of superficial muscles of leg and shoulder, or were growing from diaphragm and abdominal muscles into the body cavities. Just one out of the 112 examined intact muscle bladder worms did not have fully developed scolices but showed minute buds. The size of coenuri within a carcass with multiple infection, varied between 9 in 3 clusters in a 3 ml cyst located under the epicardium and 1102 in

Table 3. Number of protoscolices in extra cerebral coenuri of different volumes. The number depended significantly ($p<0.0001$) on the volume of cyst

Volume (ml)	Number of protoscolices (mean \pm SD)	Number of coenuri
<5	55.5 \pm 21.7	14
5 – 9.9	102.5 \pm 24	20
10 – 14.9	147.6 \pm 60.8	19
15 – 19.9	193.7 \pm 69.8	13
20 – 29.9	244.1 \pm 95.8	26
30 –	379.8 \pm 278.2	18

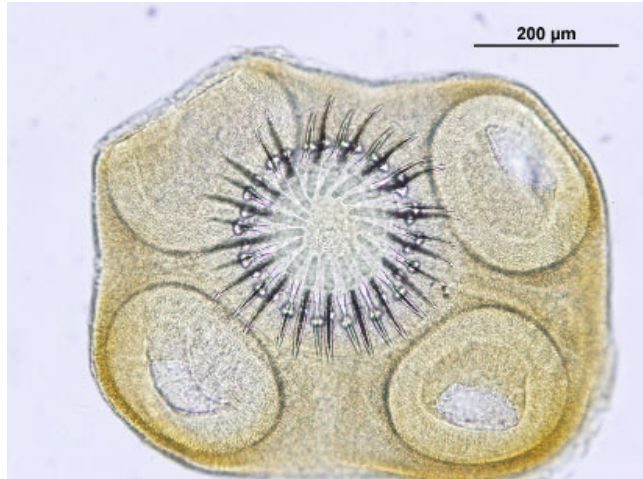


Fig. 3. Isolated protoscolex of an intra-muscular coenurus with 32 rostellar hooks arranged in two circles

72 clusters in an 86.4 ml cyst on the surface of the gracilis muscle. A comparison of the average number of protoscolices depending on cyst volumina showed significant differences ($p<0.0001$ see Table 3).

The number of rostellar hooks (Fig. 3) varied between 28 and 32. Large and small hooks were 155.6 (151 – 158) and 108.6 (102 – 120) μ m, respectively in length.

Histological sections showed that coenuri cause pressure atrophy of surrounding muscle tissues. The parasites are encircled by a host derived adventitious capsule (Fig. 4). This periparasitic granuloma is composed of macrophages, myofibroblasts and T lymphocytes.

Treatment of freshly isolated coenuri with diluted dog bile solution

Table 4. Contingency table showing the association between the presence of extra-cerebral coenuri in carcasses and *Cysticercus tenuicollis* in livers of subsequent goats

		<i>C. tenuicollis</i>		total
		+	-	
coenurus	+	35	22	57
cysts	-	267	18722	18989
total		302	18744	19046

resulted in an evagination of the protoscolices through the outer surface of the cyst (Fig. 5). In Dubecco's Modified Eagles Medium at 38 °C evaginated protoscolices remained vital for at least 3 days but did not show any growth.

During the observation period, livers of 302 goats were confiscated due to the presence of *Cysticercus tenuicollis*. In few cases *C. tenuicollis* was also attached to abdominal muscles. Thirty-five out of 57 carcasses with extra-cerebral coenurosis showed a simultaneous infection of the liver with *C. tenuicollis* (Table 4). The odds ratio in this case is OR=111.5 with a 95 % confidence interval of 62.6 to 203.2 which means a highly significant association between the occurrence of the two parasites ($p<0.0001$).

None of the confiscated livers harbored hydatid cysts nor were infected with liver flukes.

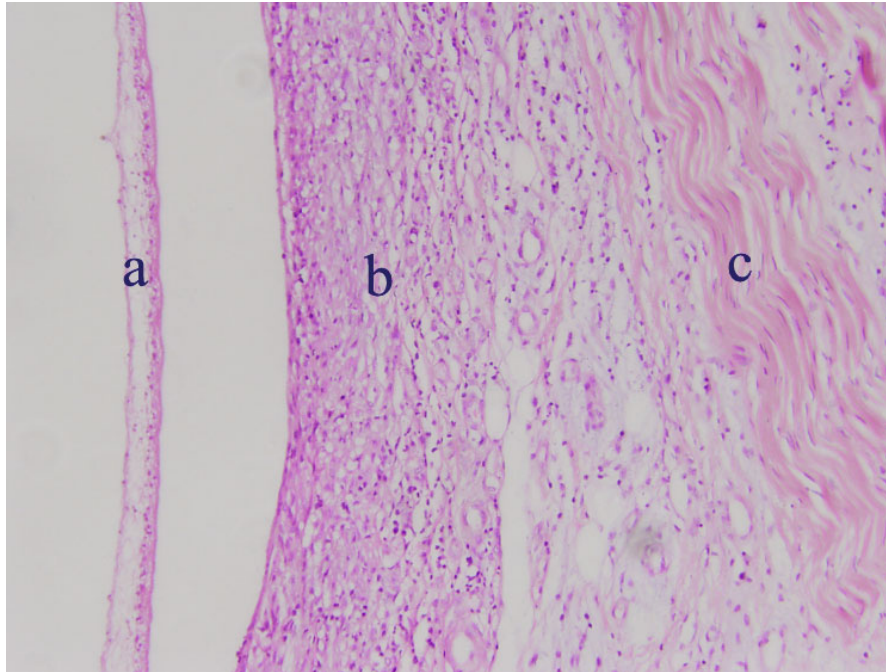


Fig. 4. Histological section of an intra-muscular coenurus and surrounding host tissues. a: coenurus, b: adventitious capsule, c: atrophied muscle fibres

Discussion

Gid had a world-wide distribution and was present in all countries with a developed sheep industry except Australia and New Zealand where cerebral coenurosis was never a problem (Bondareva, 1963). Due to pathognomonic signs of gid, introduction of veterinary-hygienic measures and the availability of praziquantel to treat

herd dogs, ovine cerebral coenurosis as a limiting factor in animal husbandry was eliminated in many countries. However, single cases are still occurring even in European countries like Switzerland (Schweizer *et al.*, 2006), Italy (Scala *et al.* 2007, Varcasia *et al.*, 2013) and Greece (Giadinis *et al.*, 2007). Extra-cerebral coenurosis with coenuri showing the same morphological features as *C. cerebralis* has been reported mainly from goats in Asia, Africa

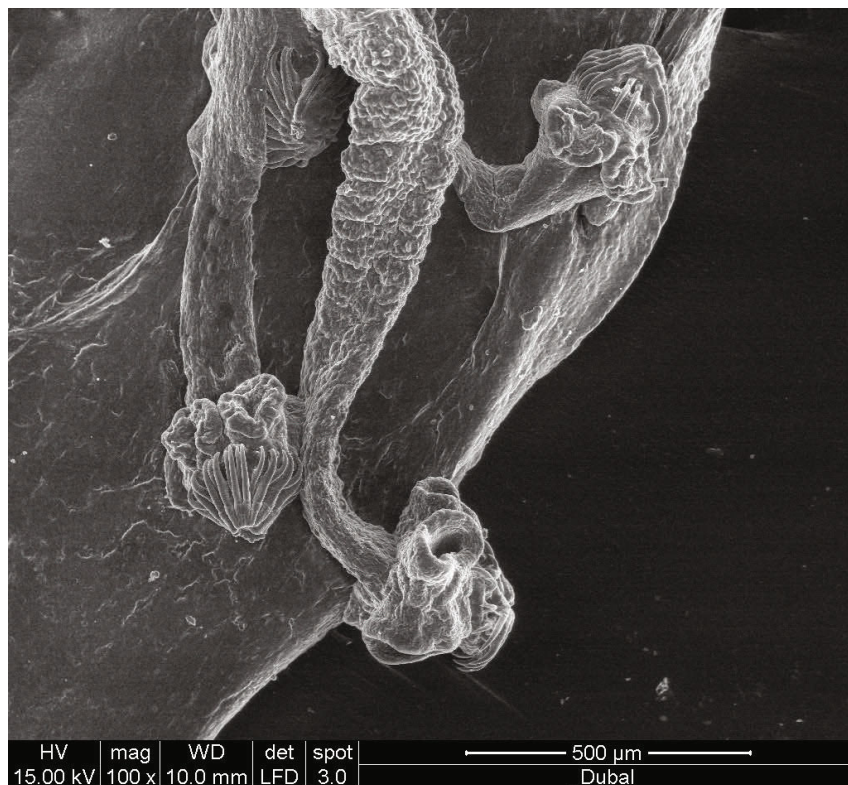


Fig. 5. Evaginated protoscolices in a coenurus after treatment with a bile solution (SEM)

and the Middle East (Table 1). Most of the communications on caprine coenurosis were case reports. One case of intra-muscular coenurosis was described also in a gemsbock (*Oryx gazelle*) in Namibia (Bohrmann, 1990).

It is believed that location of the cysts depends on host species. In sheep, cysts mature in the brain while in goats they can grow also outside of the central nervous system (Sharma & Chauhan, 2006). It was also shown that not all goats with cerebral coenuri develop clinical symptoms (Vink *et al.*, (1998). This might be the reason that goats in own investigations were clinically healthy and did not show signs of gid.

Recent molecular investigations revealed that there are some minor differences in the DNA sequence of intra muscular coenuri of goats compared to classical cerebral coenuri from sheep in Europe (Varcasia *et al.*, 2012). This finding suggests the possible existing of different strains. This theory is supported by some studies on cerebral coenurosis in goats where extra-cerebral location of cysts was not noticed (Jibat *et al.*, 2008; Javadi *et al.*, 2010; Desouky *et al.*, 2011).

Intra-muscular coenurosis does not constitute a direct health risk for consumers but the presence of parasitic cysts is nauseating and infected carcasses are objected at meat inspection where single superficial cysts can be cut out but multiple cysts lead to carcass condemnation.

With regard to location, most of the cysts in our survey were found in the hind legs. This coincides with data from other authors (Vink *et al.*, 1998; El Sinnari *et al.*, 1999; Schuster *et al.*, 2010; Kheirandish *et al.*, 2012; Madhu *et al.*, 2014).

The size of a coenurus depends on its age and on the location. While in the case of cerebral coenurosis the size of the coenurus is limited by the volume of the neurocranium and cysts do not exceed 50 mm in diameter and contain up to 300 protoscolices, extra-cerebral coenuri can grow to bigger dimensions. The largest coenurus ever reported from caprines measured 520 ml and contained 1,934 protoscolices (Hago & Abu-Samara, 1980). The biggest cyst in own material had a volume of 90 ml and the maximum number of 1,102 protoscolices was counted in a slightly smaller coenurus.

All protoscolices were attached to the inner layer of the cyst. The number of hooks and their average size matches with previously reported data (Schuster *et al.*, 2010) and correspond to data published for *M. multiceps* (Verster, 1969; Loos-Frank, 2000) being in their lower limits. The attachment of protoscolices to germinative layer of the coenurus makes it different to the classical *C. gaigeri* cyst that contains daughter cysts and where protoscolices easily get detached (Gaiger, 1907; Rao *et al.*, 1957; Bondareva, 1963).

A rare location of two coenuri under the capsule of a goat liver was reported by Woinshed and Girma (2012). In our material *Cysticercus tenuicollis* was the only hepatic parasite. It was found in 302 out of 19,046 inspected livers but the real prevalence with this metacestode was most probably much higher since the omentum is the preferred predilection site of this parasite in goats and sheep. Both parasites, *M. multiceps* and *Taenia hydatigena*, have canids as final hosts and there is no surprise if there are concurrent infections of both larval stages in goat carcasses. In our case there was a highly significant association between the two parasites. It is interesting that despite the presence of long-necked bladder worms

in livers and coenuri in carcasses none of the inspected livers showed signs of hydatid infections although goats can act as intermediate host for *Echinococcus granulosus* (Lotfi *et al.*, 2010). The limiting factor in our case might be the young age of the animals.

Acknowledgements

The authors are grateful to Dr. J. Kinne from pathology department of the Central Veterinary Research Laboratory for processing and interpreting histological samples and to Mr. S. Kumar from Gulf Support Centre for producing the scanning electron microscopical image.

References

- ABBAS, B. (1978): Coenurosis in goats in the Sudan. *Bull. Anim. Health Prod.*, 26: 363 – 364
- AFONSO, S.M., MUKARATIRWA, S., HAJOVSKA, K., CAPECE, B.P.S., CRISTOFOL, C., ARBOIX, M., NEVES, L. (2011): Prevalence and morphological characteristics of *Taenia multiceps* cysts (*Coenurus cerebralis*) from abattoir-slaughtered and experimentally infected goats. *J. Neuroparasitol.*, 2: 5 pages, DOI:10.4303/jnp/235532
- ALIM, M.A., ISLAM, M.K., RAHMAN, M.M., KHAN, M.A., MONDAN, M.M. (2002): Further observation on metacestodiosis in black Bengal goat in Bangladesh. *Pakistan J. Sci. Ind Res.*, 45: 330–333
- BANDOPADHYAYA, M.B. (1991): Prevalence of coenurus of *Multiceps gaigeri* in goat and its predilection site distribution. *Indian J. Comp. Microbio. Immunol. Infect. Dis.*, 12: 712 – 772
- BOHRMANN, R. (1990) Coenurus in the muscles of a gemsbock (*Oryx gazella*). *Vet. Parasitol.*, 36: 353 – 356. DOI:10.1016/0304-4017(90)90049-H
- BONDAREVA, V.I. (1963): *Coenurus* infections if farm and wild animals (in Russian). Izdatelstvo Akademii Nauk Kazachskoj SSR, Alma-Ata
- CHRISTODOULOPOULOS, G., KASSAB, A., THEODOROPoulos, G. (2013): Occurrence of none-cerebral coenurosis in sheep. *J. Helminthol.*, 87: 125 – 127. DOI: 10.1017/S0022149X1100085X
- DESOUKY, E.A., BADAWI, A.I., REFAT, R.A. (2011): Survey on coenurosis in sheep and goats in Egypt. *Vet. Ital.*, 47: 333 – 340. PMID:21947971
- DEY, D. (1909): *Coenurus serialis* in a goat. *J. Trop. Vet. Sci.*, 4: 556 – 560
- EL SINNARI, K.A., TAGELDIN, M.H., AL SUMRY, H.S. (1999): Outbreak of coenurosis in Anglonubian goats in the Sultanate of Oman. *Vet. Rec.*, 144: 296 – 297
- ELIAS, H., HYDE, D.M. (1980): An elementary introduction to stereology (quantitative microscopy). *Am. J. Anat.*, 159: 411 – 446
- GAIGER, S.H. (1907): *Coenurus serialis* found in two goats in India. *J. Trop. Vet. Sci.*, 2: 316 – 321
- GIADINIS, N.D., BRELLOU, G., POURLIOTIS, K., PAPAZAHARIADOU, M., SOFIANIDIS, G., POUTAHIDIS, T., PANOUSIS, N. (2007): Coenurosis in a beef cattle Herd in Greece. *Vet. Rec.*, 161: 697 – 698. DOI: 10.1136/vr.161.20.697
- GODARA, R., BORAH, M.K., SHARMA, R.I., JANGIR, B.L. (2011): Caprine coenurosis with special reference to hepatic coenurosis. *Comp. Clin. Pathol.*, 20: 277 – 280. DOI: 10.1007/s00580-010-1108-0

- GOEZE, J.A.E. (1780): Das Drehen der Schafe. *Neue oeconomische Nachrichten der patriotischen Gesellschaft in Schlesien* 1: 21 – 27
- GOSH, R.C., DUBEY, S., MANDAL, S.C., SHARMA, N. (2005): Occurrence of *Coenurus gaigeri* cyst in a goat. *Indian Vet. J.*, 82: 90 – 91
- HAGO, B.E.D., ABU-SAMARA, M.T. (1980): A case of *Multiceps gaigeri* in goat. *Vet. Parasitol.*, 7: 191 – 194
- HALL, M.C. (1916): A new and economically important tapeworm, *Multiceps gaigeri* from the dog. *J. Am. Vet. Med. Assoc.*, 50: 214 – 223
- ISLAM, S., KALITA, D., BHUYAN, D., RAHMAN, T., SALEQUE, A. (2006): Ocular coenurosis in goat. *J. Vet. Parasitol.*, 21: 53 – 55
- JAVADI, A., HASHEMZADI, F.H., SHABAZI, P. (2010): Infection rate of brain *Coenurus cerebralis* in slaughtered sheep and goats in Tabriz abattoir. *Sci. Res. Iranian J.*, 6: 59 – 63
- JIBAT, T., EUJETA, G., ASFAW, Y., WUDIE, A. (2008): Causes of abattoir condemnation in apparently healthy slaughtered sheep and goats at Helmex abattoir, Debre Zeit, Ethiopia. *Rev. Med. Vet.*, 159: 305 – 311
- KHEIRANDISH, R., SAMI, M., AZIZI, S., MIRZAEI, M. (2012): Prevalence, predilection sites and pathological findings of *Taenia multiceps* coenuri in slaughtered goats from south-east Iran. *Onderstepoort J. Vet. Res.* 79, E1 – 5. DOI: 10.4102/ojvr.v79i1.436
- LESKE, N.G. (1780): *Vom Drehen der Schafe und dem Blasenwurm im Gehirn derselben, als Ursache der Krankheit.* 52 pp. Leipzig, Octavo
- LOOS-FRANK, B. (2000) An update of Versters (1969): 'Taxonomic revision of the genus *Taenia* Linnaeus' (Cestoda) in table format. *Syst. Parasitol.*, 45: 155 – 183
- LOTFI, A., YUSEFKHANI, M., SAMAVATIAN, A., YILMAZ, H., TAS CENGİZ, Z., VALIOU, M. (2010): Prevalence of cystic echinococcosis in slaughtered sheep and goats in Ahar Abattoir, northwest part of Iran. *Kafkas Univ. Vet. Fak. Derg.*, 16: 515 – 518. DOI: 10.9775/kvfd.2010.1737
- MADHU, D.N., MAHAN, T., SUDHAKAR, N.R., MAURYA, P.S., BANERJEE, P.S., SAHU, S., PAWDE, A.M. (2014): *Coenurus gaigeri* cyst in the thigh of a goat and its successful management. *J. Parasit. Dis.*, 38: 286 – 288. DOI: 10.1007/s12639-013-0242-4
- MOGHADDAR, N. (2007): Occurrence of *Coenurus gaigeri* in goats in Shirz, Iran. *J. Appl Animal Res.* 31, 83 – 84. DOI: 10.1080/09712119.2007.9706635
- NOURANI, H., KHEIRABADI, K.P. (2009): Cerebral coenurosis in a goat: pathological findings. *Comp. Clin. Pathol.*, 18: 85 – 87. DOI: 10.1007/s00580-008-0742-2
- OGE, H., OGE, S., GONNENC, B., OZBAKIS, G., ASTI, C. (2012): Coenurosis in the lumbar region of a goat: case report. *Vet. Med.*, 57: 308 – 313
- RAMADAN, R.O., MAGZOUN, M., ADAM, S.E.I. (1973): Clinicopathological effect in a Sudanese goat following massive natural infection with *Coenurus gaigeri* cysts. *Trop. Anim. Health Prod.*, 5: 196 – 199
- RAO, R.S., BHATAVDEKAR, M.I., DATHA, K.T. (1957): Morphology and development of *Coenurus gaigeri* Hall in a ewe with particular reference to the taxonomy of the genus *Multiceps*. *Bombay Vet College Mag.*, 6: 12 – 16
- SCALA, A., CANCEDDA, G.M., VARCASIA, A., LIGIOS, C., GARIPPA, G., GENCHI, C. (2007): A survey of *Taenia multiceps* coenurosis in Sardinian sheep. *Vet. Parasitol.*, 143: 294 – 298. DOI:10.1016/j.vetpar.2006.08.020
- SCHUSTER, R. K., SIVAKUMAR, S., WIECKOWSKY, T. (2010): Non-cerebral coenurosis in goats. *Parasitol. Res.*, 107: 721 – 726. DOI: 10.1007/s00463-010-1919-6
- SCHWEIZER, G., GRÜNFELDER, F., SYDLER, T., RADEMACHER, N., BRAUN, U., DEPLAZES, P. (2006): Imported coenurosis in sheep. *Schweiz. Arch. Tierh.*, 148: 490 – 49. DOI: 10.1024/0036-7281.148.9.490
- SHARMA, D.K., CHAUHAN, P.P.S. (2006): Coenurosis status in Afro-Asian region: a review. *Small Ruminant Res.*, 64: 197 – 202. DOI: 10.1016/j.smallrumres.2005.05.021
- SHIVAPRAKSH, B.V., THIMMA, R.P.M. (2009): An outbreak of multiple subcutaneous *Coenurus* cysts in goats. *J. Vet. Parasitol.*, 23: 199 – 200
- VARCASIA, A., JIA, W.Z., YAN, H.B., MANUNTA, M.L., PIPIA, A.P., GARIPPA, G., SCALA, A., SCHUSTER, R.K. (2012): Molecular characterization of subcutaneous and muscular coenurosis of goats in United Arab Emirates. *Vet. Parasitol.*, 190: 604 – 607. DOI.org/10.16/j.vetpar.2012.07012
- VARCASIA, A., PIPIA, A.P., ARRU, D., PES, A.M., TAMPONI, C., DORE, F., GARIPPA, G., SCALA, A. (2013): Morphological and molecular characterization of bovine coenurosis in Sardinia, Italy. *Parasitol. Res.*, 112: 2079 – 2082. DOI: 10.1007/s00436-012-3257-3
- VERSTER, A. (1969) A taxonomic revision of the genus *Taenia* Linnaeus, 1758 s.str. *Onderstepoort J. Vet. Res.*, 36, 3 – 58
- VINK, W.D., LOPEZ-PEREIRA, C.M., NOTA, A., DE BALOGH K.K.I.M. (1998): Prevalence of coenurosis in goats in Tete Province of Mozambique. *Cien. Tech. Vet.*, 3: 29 – 34
- WOINSHED, S., GIRMA, G.G. (2012): Prevalence, risk factors, and distribution of *Cysticercus tenuicollis* in visceral organs of slaughtered sheep and goats in central Ethiopia. *Trop. Anim. Health Prod.*, 42: 1049 – 1051. DOI: 10.1007/s11250-010-9537-y
- YIAN, R.-L., WANG Y.-L. (1992): Study on the biology of coenurus in goat and sheep. *Wuyi Sci.*, J. 9: 207 – 213 (In Chinese)