EMASPÕTRADE LUULISE VAAGNA EALISED MUUTUSED

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ABSTRACT. Age-related changes in the osseous pelvis of female elks. *The osseous pelvis of 18 variously aged female elks were studied by preparation, pelvimetry, X-rays, and biological maceration. The teeth served as the indicator of the age of the animals. The pelvises were divided into five groups: calves (0.5 y), mating-aged heifers (1.5 y), primiparae (2.5 y), adults (5.5 y) and old animals (10 y and older).*

An elk pelvis reaches its long and slim shape by sexual maturity. The ratio of the pre-acetabulum to the post- acetabulum is 3:2. Both the cranial and the caudal pelvic apertures are cranioventrocaudally oval. The transverse diameter of the cranial pelvic aperture reaches its maximum in the third year of life; the diameter of the caudal aperture, however, increases little by little and reaches the diameter of the cranial aperture by the sixth year of life. Also, the vertical measurement of the pelvic cavity from the sacral apex increases to a considerable degree with age. The widening of the part of pelvis behind the acetabulum with age is also indicated by increased distances between the opposite ischial spines, acetabula, and lesser sciatic notches. A half-year-old calf has no interischial bone, but it is already forming in a year-and-a-half-old heifer. By the tenth year the interischial bone has already become fully bilaterally attached to the ischia. In addition to to the interischial bone a year-and-a-half-year-old female heifer has apophyseal ossified nodes also on coxal, ischial, and sacral tubers. The ossification of the pelvic symphysis begins from the caudal part of the ischial symphysis, followed by the ossification of the cranial part of the pubic symphysis, and finally the region of the caudal rami of the pubes. The dorsal pubic tubercle that is reduced with age has the shape of a crest and protrudes cranially in calves and heifers but is barely noticeable by age six. The anterior of the pubic pecten becomes concave in the caudal direction, and a furrow that runs parallel to the edge of the pecten has formed between the iliopubic eminences. By contrast, according to our data, after the first parturition the sacral curve and the diameter of the acetabulum is not related to age.

Keywords: *elk, pelvis, morphogenesis, age-releated changes.*

Sissejuhatus

Skandinaavias, Baltikumis ja Venemaa metsatundrates elutsev euroopa põder on selle piirkonna üks olulisemaid jahiulukeid, kes aitab rahuldada nii jahikirge kui katta inimese toidulauda. Kui Euroopas keskmiselt huvitub jahipidamisest 1% elanikest, siis Põhjamaades tegeleb taolise harrastusega 4–6% elanikest. Samuti paiknevad selles piirkonnas suurimad põtrade asurkonnad (Randveer, 2003).

Eestis on loenduse andmetel 10 000–12 000 looma, kellest aastas kütitakse ligikaudu 4000 (Randveer, 2003). Võrreldes kodustatud sõralistega sõltub tema sigimine paljuski ilmastikust, toidulauast, jahimeeste tegevusest jne. Seega peaks ka põdra skelett olema kohastunud taolise sesoonse eluviisiga. Põdra jäsemete luid on uuritud, kuid viiteid vaagna uurimistulemuste kohta me kättesaadavas kirjanduses ei leidnud.

Võtmesõnad: põder, vaagen, morfogenees, ealised muutused.

Materjal ja metoodika

Uurimismaterjaliks olid 18 emaspõdra vaagnad, mis pärinesid Eestis kütitud isenditelt. Loomade vanus määrati ligikaudselt hammaste järgi (Klevezal, Klejnenberg, 1967; Knorre, Šubin, 1959). Selle järgi jaotati loomad gruppidesse:

- 0,5-aastased vasikad;
- 1,5-aastased paaritusealised mullikad;
- 2,5-aastased esmaspoegijad;
- 5,5-aastased täiskasvanud lehmad;
- 10-aastased ja vanemad lehmad.

Eeltoodud jaotuse puhul on lähtutud loomade normaalsetest elamistingimustest. Kuid halbade ilmastikuolude ning kehva toidu puhul võib mullikate paaritus- ja poegimisaeg nihkuda üks kuni kaks aastat hilisemaks (Randveer, 2003).

Võrdluseks kasutati EPMÜ loomaarstiteaduskonnas paikneva normaalanatoomia muuseumi kogudes olevate sõraliste ning hobuste skelette.

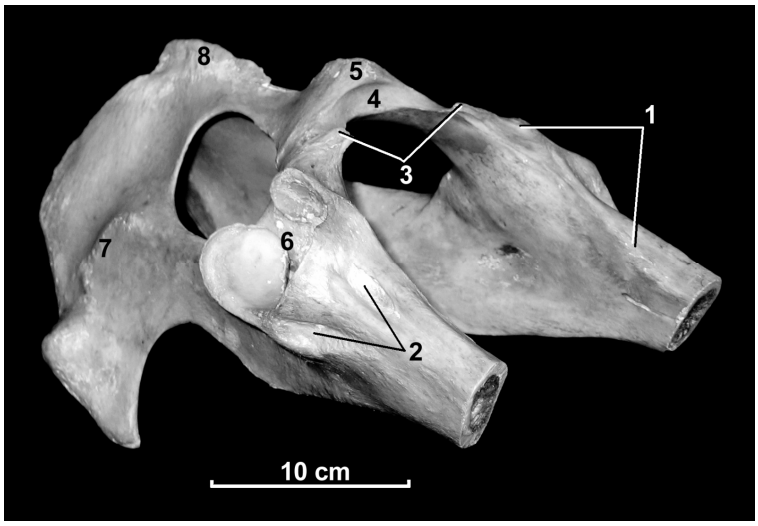
Pelvimeetriliste mõõtmiste tegemiseks prepareeriti luuline vaagen lihaskoest ja kõõlustest välja. Röntgenoloogiliselt uuriti vaagna luid nii enne kui pärast bioloogilist matseratsiooni. Viimane oli vajalik luudevaheliste kõhreliste ühenduste eemaldamiseks. Matseratsioon toimus 3–4 nädala jooksul termostaadis veekeskkonnas.

Uurimistulemused ja arutelu

Põdra vaagen on väljavenitatud ja kitsas. Taolise kuju annavad talle pikk niudeluukeha ja puusaköber. Põdral on niudeluukeha veise ja väikemäletsejalistega võrreldes suhteliselt pikem, suur istmikusälk tõuseb laugelt istmikuharjale. Suur istmikusälk on madal, madalam kui väike istmikusälk. Sälgu kraniaalses servas niudeluutiival asuvad väikesed luulised kidad. Tiivad ise on horisontaalsema asetusega kui veisel.

Puusaköber meenutab rombi, kuigi koosneb kolmest köprusest nagu veiselgi – lateraalne, mediaalne ja kraniaalne (*tuberositas lateralis*, *medialis et cranialis tuberis coxae*). Mediaalne köprus on veidi üles ning väljapoole pöördunud. Puusaköber on tugevalt kraniolateraalselt venitunud, mis annab kogu vaagnale pikema ilme. Köbru kraniaalsel pinnal kulgeb hari; köbru pikkus on täiskasvanud põdralehmal 7,2–8,4 cm. Vanadel loomadel oleme näinud niudeluutiiva mediaalsel pinnal puusaköbru kraniaalsest köprusest allpool mõne millimeetri pikkusi kidasid. Niudeluuhari on mediaalses nurgas paksenenud ja moodustab tagasihoidliku ümara ristluumise köbru. Mõlemad köbrud asuvad mediaansest ristluuharjast madalamal.

Niudeluukeha ventromediaalsel küljel paikneb luuline hari (joonis 1), mida A. I. Akajevskij (1939) nimetab põhjapõtradel niude-süleluu harjaks (*crista iliopubica*) ning mis tegelikult paikneb ainult niudeluul. Kraniaalselt algab see kõrvja pinna tagant, kulgeb diagonaalselt piki niudeluukeha ning lõpeb puusanapa äärel selle keskpaigas kõrgendiga. Harjal asub kareda pinnana väikese nimmelihase köbruke. Niude-süleluu hari esineb ka veisel nõrgalt arenenuna väikese nimmelihase köbrukesest alates, kuid ei ulatu puusanapani. Niudeluukeha ventraalsel ja lateraalsel pinnal puusanapast kraniaalselt asuvad reie-sirglihase kinnitumiseks kaks lohku (*foveae m. recti femoris*).



Joonis 1. 12 aasta vanuse põdralehma vaagen kranioventraalselt
Figure 1. *The cranioventral view of the pelvis of the 12 years old female elk*
1 – *crista iliopubica*, 2 – *fovea m. recti femoris*, 3 – *eminentia iliopubica*, 4 – *sulcus pectinis ossis pubis*, 5 – *tuberculum pubicum ventrale*, 6 – *acetabulum*, 7 – *tuberculum m. quadrati femoris*, 8 – *eminentia symphysialis*

Kraniaalne vaagnaava on vertikaalselt ovaalne. Seda ventraalselt piiritleval süleluul esineb noortel loomadel dorsaalsel süleluuköbrukesel mõne millimeetri pikkune süleluukammile ulatuv kraniaalne osa. Vananedes viimane taandub ja niude-süleluu kõrgendite vahele moodustub vagu (*sulcus pectinis ossis pubis*). Vastandina põdrale esineb veisel süleluuoga, mis säilib kõrge vanuseni.

Dorsaalne ja ventraalne süleluuköbruke on põdramullikatel enam-vähem võrdse pikkuse ja kõrgusega. Dorsaalne on harjakujuline, olles kraniaalselt järsem ning madaldudes kaudaalses suunas laugelt. Vanadel loomadel on see täielikult taandarenenud. Ventraalne süleluuköbruke vananedes ei redutseeru.

Süleluukehal esinev niude-süleluu kõrgend on massiivsem vanematel isenditel. Vastaspoolsete kõrgendite vahel paikneb süleluude-eesne kõõlus. Süleluukeha koos oma kraniaalse haruga on tunduvalt suurema läbimõõduga kui liidust moodustada aitav kaudaalne haru.

Toppemulk on kraniolateraalselt ovaalne ning tema puusanapapoolses osas on sügav sõrmelaiune sälk (*incisura foraminis obturati*) toppenärvi ja -arteri jaoks. Selline sälk esineb ka hirvedel ja metskitsedel.

Vaagnapõhi on kraniaalses osas lame, kuid toppemulkudest tagapool on see renjas ning tõuseb veidi kaudaalses suunas. Kõige sügavam on vaagnapõhi vaheistmikuluu kraniaalse haru kohal.

Põdralehmadel on istmikuluuplaat suhteliselt laiem kui veisel, seetõttu on ka vaagnaõõs sügavam. Väike istmikusälk on suurest sügavam ja tunduvalt järsem, kuid veisega võrreldes on mõlemad madalad. Väikeses istmikusälgus on vagu (*sulcus incisurae ischiadici minoris*) sisemise toppelihase kõõluse jaoks. Kuigi A. I. Akajevskij (1939) järgi on taolise vao olemasolu väga tüüpiline põhjapõdrale, oleme seda täheldanud ka hobuste vaagnatel.

Põdralehmal on meie andmetel istmikuluude plaatidevaheline nurk alati suurem kui istmikukaare nurk (tabel 1), kuid see jääb enamasti ikka teravnurgaks. Istmikukaar on alati teravnurkne. Vanematel loomadel esineb istmikukaares liiduse kohal kahe sõrme laiune sälk, mis esineb ilmekalt näiteks ka aksishirvel.

Teravad istmikuharjad kaarduvad vaagnaõõne poole. Vaagna kõige kitsamaks kohaks on aga nagu hobuselgi puusanapast tagapool olev vastaspoolsete istmikuluukehade vahemik.

Istmikuköbru pikkus on täiskasvanud emaspõdral 5,6–6,7 cm ning see kulgeb peaaegu sirgelt dorsoventraalses suunas. Köbrul eristatakse kraniaalset, lateraalset ja kaudaalset köprust (*tuberositas cranialis, lateralis et caudalis tuberis ischiadici*), kusjuures viimane paikneb teistest tagapool eraldi. Kõik köprused on suhteliselt siledad.

Tabel 1. Tähtsamad pelvimeetrilised näitajad
Table 1. *Major pelvimetric indicators*

Näitajad *Indicators*	Vanus aastates / *Age in years*					Muutused pärast esmaspoegimist *Changes after first calving*
	0,5	1,5	2,5	5,5	10–12	
Anatoomiline diameeter (cm) *Anatomical diameter (cm)*	15,4	19,7	20,1	21,1	21,8	+
Mediaanmõõt (cm) *Median measurement (cm)*	10,6	17,4	17,8	19,0	18,9	+
Kraniaalne ristimõõt (cm) *Cranial transverse measurement (cm)*	9,1	12,1	13,0	13,0	13,0	0
Kaudaalne ristimõõt (cm) *Caudal transverse measurement (cm)*	7,5	11,6	12,4	12,9	13,5	+
Vertikaalmõõt* (cm) *Vertical measurement* (cm)*	9,2	13,0	13,8	14,4	14,9	+
Istmikuharjadevaheline ristimõõt (cm) *Transverse measurement between ischial crests (cm)*	7,2	10,3	10,5	10,9	11,2	+
Vaagnapõhja pikkus (cm) *Length of the pelvic floor (cm)*	11,1	15,0	14,5	15,4	15,1	±
Istmikuluude plaatidevaheline nurk (°) *Angle between ischial plates* (°)	62°	88°	85°	87°	90°	+
Istmikukaare nurk (°) *Angle of ischial arch* (°)	62°	82°	68°	64°	69°	±
Väikeste istmikusälkude vaheline ristimõõt (cm) *Transverse measurement between the small ischial notches (cm)*	7,0	10,6	11,0	11,2	11,6	+
Ristluu kumerus** (cm) *Sacral curvature** (cm)*	3,4	4,2	3,4	3,0	3,7	±
Vaheistmikuluukeha pikkus (cm) *Length of the body of the interischial bone (cm)*	–	2,6	2,6	3,1	2,6	±
Vaheistmikuluu kraniaalse haru pikkus (cm) *Length of the cranial ramus of the interischial bone (cm)*	–	4,8	5,0	4,7	6,8	±
Puusanappadevaheline ristimõõt (cm) *Transverse measurement between the acetabula (cm)*	9,7	13,0	13,5	14,0	14,2	+

* Vertikaalmõõt on vaagnaõõne maksimaalne kõrgus mõõdetuna süleluukammi ja ristluutipu vahelt / *The vertical measurement is the maximum height of the pelvic cavity between the pubic pecten and the apex of the sacrum*

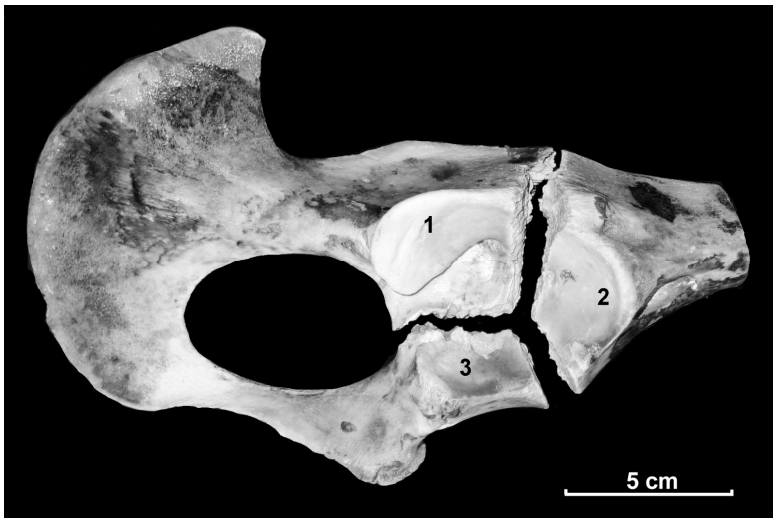
** Ristluu kumerus on ristluu ventraalse pinna maksimaalne kumerus mõõdetuna ristluuneeme ja -tippu ühendavalt sirgjoonelt
The sacral curvature is the maximum curvature of the ventral surface of the sacrum on the straight line between the sacral promontory and the apex

Vaagnaliidust tugevdab ventraalselt vaheistmikuluu (*os interischiadicum*) (Nahkur *et al*., 2003), kuna liidus jääb vastaspoolsete istmikuluu harude ja süleluu kaudaalharude vahel pikaks ajaks kõhreliseks. Vaheistmikuluukeha aitab moodustada istmikukaart, temast lähtuvad ka istmikuluule kinnituvad lühikesed kaudaalharud. Viimased kasvavad vananedes istmikuluuplaatidega täielikult kokku. Piki vaagnaliidust kasvav kraniaalne haru on luu kehast pikem. Sümfüsiaalhari on nõrgalt arenenud, suhteliselt ühtlase kõrgusega ning madaldub kraniaalses suunas.

Dorsaalset vaagnaseina moodustav ristluu koosneb põdralehmal enamasti viiest lülist, kuid sellega võib liitunud olla ka esimene sabalüli. Ristluutiivad on lühikesed, tiibade ja külgosade ning lülikehade vahel moodustuv ventraalselt avatud nurk on teravam kui veisel. Mediaanset ristluuharja moodustavate kolme kraniaalse lüli ogajätked on kokku kasvanud ja selle dorsaalne serv jämenenud. Neljanda ja viienda lüli ogajätked on väga madalad ning osaliselt liitunud. Seetõttu väheneb harja kõrgus järsult kaudaalses suunas. Ristluu kumerus on veisega võrreldes suurem. Oma maksimaalse kõrguse saavutab see kolmanda ja neljanda lüli piiril.

0,5-aastasel vasikal, kes kaalub umbes 100 kg, on luud veel käsnjad ja siledad. Niude-süleluu kõrgend, väikese nimmelihase köbruke ning istmikuköbru kaudaalne köprus on vaevumärgatavad. Nõrgalt on arenenud ka sälk toppemulgu kraniaalses osas; toppemulgu suund on kraniolateraalne. Apofüsaarsed luustumistuumad ja vaheistmikuluu puuduvad.

Puusaluu kolm komponenti eraldusid matseratsiooni käigus puusanapas üksteisest. Suurema osa puusanapast moodustab istmikuluu, kõige vähem osaleb selles süleluu (joonis 2). Ristluulülid pole veel kokku kasvanud.



Joonis 2. 0,5 aasta vanuse põdralehma puusanapp
Figure 2. *The acetabulum of the 0,5 year old female elk*
1 – *os ischii*, 2 – *os ilium*, 3 – *os pubis*

Tugevamalt on arenenud niudeluukehal ventraalselt asetsev reiesirglihase auk, väikeses istmikusälgus olev vagu ning puusa- ja ristluumine köber. Dorsaalne süleluuköbruke on harjakujuline, etteulatuva kraniaalse osaga. Ventraalse köbrukese kuju on samasugune nagu täiskasvanud lehma köbrukesel, kuid ta sisaldab vaagnaliiduse kohal rohket kõhrelist täitemassi.

Vastaspoolsete istmikuluude plaatidevaheline ja istmikukaare nurk on võrdsed – 62º. Kraniaalne vaagnaava on kaudaalsest laiem ja ligi viis sentimeetrit kõrgem.

1,5-aastasel põdral esinevad köprudel juba luustumistuumad, mis paiknevad eraldi apofüüsidel ega ole omavahel liitunud. Istmikukaarel on välja kujunemas vaheistmikuluu, kuid vaagen poolitus matseratsiooni käigus vaagnaliidusest. Samuti eraldus viies ristluulüli ülejäänud ristluust.

Dorsaalne süleluuköbruke on harjakujuline, ventraalne aga pisut lamedam. Väikese nimmelihase köbruke, niude-süleluu hari ning sälk toppemulgus on nõrgalt arenenud.

Kraniaalne vaagnaava on kaudaalsest pisut laiem ja keskmiselt kahe sentimeetri võrra kõrgem. Istmikuluude plaatidevaheline ja istmikuluukaare nurk on vasikaga võrreldes oluliselt suurenenud. Vaheistmikuluu mõõtmed on võrreldavad täiskasvanud looma vaheistmikuluu mõõtmetega.

2,5-aastase esmaspoegija vaagen on arenenud laiusesse ja kõrgusesse. Luustumistuumad istmikuköbru kraniaalsel ja lateraalsel köprusel on omavahel liitunud. Kaudaalse köpruse luustumistuum ning vaheistmikuluu kaudaalsed harud ei ole liitunud.

Dorsaalne süleluuköbruke on veel harjakujuline ja terav, ventraalne aga lamedam. Niude-süleluu hari on mullikaga võrreldes rohkem arenenud, toppemulgus asuv sälk on moodustunud nagu täiskasvanud lehmalgi, kuid väikese nimmelihase köbruke on vaevumärgatav.

Võrreldes pooleteiseaastasega pole vaagnaõõne kuju oluliselt muutunud, st ta on ühtlaselt ovaalne, kitsenedes istmikuharjade ja istmikuluude kehade kohal. Istmikuharjad kaarduvad vaagnaõõne poole, muutes

puusanappade ja toppemulkude kraniaalses osas vaagnaõõne pealt kitsamaks. Istmikuluu pikkus pole oluliselt muutunud, kuid niudeluu on veidi pikenenud.

5,5-aastasel põdral peaks luude kasv kirjanduse andmetel olema lakanud. Tema istmikuköbru köprused on omavahel ning vaheistmikuluu kaudaalsete harudega kokku kasvanud, kuid liitumiskohad on veel märgatavad. Sama on toimunud puusa- ja ristluumise köbruga. Ühel vaagnal eraldusid puusa- ja ristluumise köbru veel täielikult väljakujunemata köprused matseratsiooni käigus.

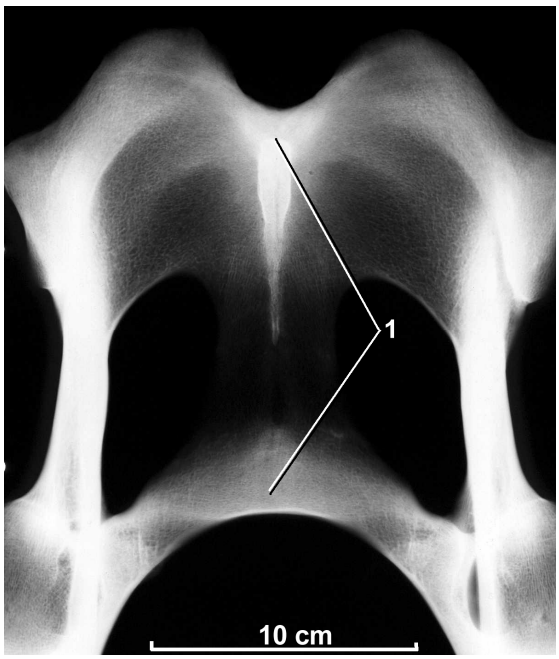
Vaheistmikuluu on istmikuluudega luuliselt liitunud, samuti süleluude kraniaalsed harud omavahel. Istmikuluuharude vahel istmikuliiduses leidub veel väike pilu.

Dorsaalne süleluuköbruke on lamendunud ja süleluukammile moodustunud vagu. Ventraalsel süleluu-köbrukesel on vaagnaliiduse kohale moodustunud luuline sild. Niude-süleluu hari on välja arenenud ning ulatub puusanapa liigeseõõniseni. Istmikuluukeha mediaalsel pinnal esineb väikesest istmikusälgust poolviltu toppemulgu kraniaalse otsani ulatuv luuline hari.

Kraniaalse ja kaudaalse ava ristimõõdud on peaaegu võrdsed. Kaudaalne vaagnapiirkond on muutunud laiemaks, kasvanud on ka vaagna kõrgus ning põhja pikkus. Viimase suurenemisele aitab kaasa vaheistmikuluu areng.

Niudeluutiibade mediaalsel pinnal puusaköprude kohal esinevad väikesed terava otsaga luulised kidad.

10–12-aastase põdra vaagen pole eelmise vanusegrupi vaagnatega võrreldes oluliselt muutunud. Süleluu dorsaalne pind on sile, lame. Vaagnaliidus on kokku kasvanud (joonis 3), selle ventraalsel pinnal on näha vagu istmiku- ja süleluu harude vahel. Kaudaalselt kaardunud süleluukammil moodustunud sügav vagu asetseb niude-süleluu kõrgenditest ventraalselt. Ventraalse süleluuköbrukese kraniaalne serv ulatub süleluukammist ettepoole ning köbruke ise on reljeefsem. Süleluude harude paksus ei ole vananedes oluliselt muutunud.



Joonis 3. Röntgenogramm 12 aasta vanuse põdra-lehma vaagnapõhjast
Figure 3. *The radiograph of the pelvic floor of the 12 years old female elk*
1 – symphysis pelvina

Vaheistmikuluu kraniaalne haru on pikenenud, kuigi ulatub ainult toppemulgu kaudaalse kolmandikuni nagu ka noorematel loomadel.

Kraniaalne ristimõõt on kaudaalsest väiksem, kuid kraniaalne ava on jäänud kaudaalsest kõrgemaks. Vaagnapõhja üldpikkus enam suurenenud ei ole.

Kokkuvõte ja järeldused

Emaspõtrade vaagna uurimisel on koduloomadega võrreldes probleemiks vanuse määramise ligikaudsus ning saadava materjali ebaühtlus. Põtrade kasv ja sigimine on tihedalt seotud asjaoluga, kas aastad on olnud neile soodsad või mitte (ilmastik, toidulaua olemasolu jne) ning seetõttu võivad ühevanuste loomade vaagnad olla väga erineva suurusega. Siiski võib tähele panna, et põdralehma vaagna väljakujunemine ning vaagnaliiduse luustumine algab suhteliselt hilja ning kestab seetõttu kauem. Emaslooma vaagnale iseloomulikud jooned ilmnevad suguküpsuse ajaks, kuid väiksemate lihaste kinnitumiseks vajalike luuliste struktuuride areng kestab vähemalt kuuenda eluaastani. Erandiks on dorsaalne süleluuköbruke, mis selleks ajaks on peaaegu täielikult redutseerunud. Kuid ka vana põdralehma vaagna apofüüsid ja lihasjooned jäävad oma suuruselt alla näiteks veise vastavatele struktuuridele. Seega võib nõustuda L. Bartosiewiczi (1987) väitega, et veistel on kere lihased

paremini arenenud kui põtradel. Kolmandal eluaastal on vaagnaliidus veel täielikult luustumata, kuuendal aastal on süleliiduse kraniaalne ja istmikuliiduse kaudaalne osa luustunud ning üle kümneaastasel on kogu liidus kokku kasvanud.

Üheks omapäraseks ealiseks muutuseks emaspõdra vaagnal on süleluukammi nihkumine koos dorsaalse köbrukese taandarenguga. Kui noortel loomadel on viimane harjakujuline ning kraniaalselt etteulatuv, siis kuuendal eluaastal on ta redutseerunud, süleluukamm nihkunud kaarjalt kaudaalses suunas ning niude-süleluu kõrgendite vahele on moodustunud vagu. Vanuse kasvades ulatub hoopis ventraalne süleluuköbruke kraniaalselt esile. Samaaegselt suureneb puusanappade vahekaugus, kuid liiduse kohalt mõõdetav süleluu kraniaalse haru läbimõõt ei vähene oluliselt, olles pooleaastasel vasikal 3,6 cm, pooleteiseaastasel keskmiselt 3,7 cm ja vanal lehmal 3,1 cm. Kui veistel säilib dorsaalne süleluuköbruke mõnel lehmal ka vanas eas (Jalakas, 2004), siis kõigil meie poolt uuritud põtrade vaagnatel oli see taandarenenud.

Emaspõdra vaagnal on struktuure, mis arenevad välja suguküpsuse saabudes ning mille proportsioonid püsivad enam-vähem samadena kogu eluea. Näiteks puusanapa suurus ja kuju, toppemulgu ja vaheistmikuluukeha pikkus, diagonaalmõõt jt.

Vananedes areneb põdralehma vaagen kraniaalses osas enam kõrgusesse ja kaudaalses osas laiusesse. See aitab vanemas eas ilmselt kompenseerida vaagnaliiduse jäikust sünnitusel. Samuti on oluline asjaolu, et põdralehmadel ei ole ristluu-niudeluu liiges luustunud isegi vanas eas – kõigil juhtudel eraldus ristluu matseratsiooni käigus. Kirjanduse andmetel sünnib vanematel põdralehmadel rohkem mitmikuid, kes on kergemad ja väiksemad – vasikate keskmine sünnimass on 11–16 kg (MacDonald, Barret, 2002). Seetõttu on nende sünnitus kerge. Esmaspoegijatel sünnib üks vasikas, kuid neil aitab vaagnaõõne suurenemisele kaasa vaagnaliiduse elastsus.

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Kirjandus

Akajevskij, A. I. 1939. Anatomija severnogo olenja. Leningrad: Glavsevmorputi.

Bartosiewicz, L. 1987. Bone morphometry and function: a comparison between cattle and european elk. Acta Veterinaria Hungarica 35 (4), p. 437–448.

Jalakas, M. 2004. Obstetric Aspects of the Pelvis and Suspensory Apparatus in Estonian Holstein Cows. Doctoral Dissertation. Tartu.

Klevezal, G. A., Klejnenberg, S. E. 1967. Opredelenie vozrasta mlekopitajuščih po sloistym strukturam zubov i kosti. Moskva: Nauka.

Knorre, E. P., Šubin, G. G. 1959. Opredelenie vozrasta losja. Trudy Pečoro-Ilyčskogo gosudarstvennogo zapovednika. Vyp. 7.

MacDonald, D. W., Barret, P. 2002. Euroopa imetajad. Tallinn: Eesti Entsüklopeediakirjastus.

Nahkur, E., Jalakas, M., Andrianov, V., Ernits, E., Järv, E. 2003. A Comparative Anatomical Study of the Pelvis in the Contemporary and Medieval Cow and Elk. – Veterinarija ir Zootechnika. T. 24 (45), p. 40–44.

Randveer, T. 2003. Jahiraamat. Tallinn: Eesti Entsüklopeediakirjastus.

Age-related changes in the osseous pelvis of female elks

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Introduction

The European elk that lives in the forest tundras of Scandinavia, the Baltic countries, and Russia is one of the most important game animals that helps to satisfy the passion for hunting and to provide food. While in Europe on average 1 per cent of the population is interested in hunting, in the Nordic countries 4–6 per cent of people take an interest in this pastime. Also, the largest elk populations inhabit this region (Randveer, 2003).

It is estimated that there are 10,000–12,000 elks in Estonia of which about 4,000 are hunted annually (Randveer, 2003). Unlike the domesticated hoofed animals, its reproduction largely depends on the climate, available food, and hunting. Therefore, one might assume that the skeleton of the elk has adapted to a seasonal lifestyle. While there is some literature about the bones of the elk limbs, we did not find any research concerning the pelvis.

Materials and methods

The study is based on 18 pelvises of female elks that had been hunted in Estonia. The age of the animals was determined by studying their teeth (Klevezal' and Klejnenberg, 1967; Knorre and Shubin, 1959). On this basis the animals were divided into the following groups:

- 0.5-year-old calves;
- 1.5-year-old mating-aged heifers;
- 2.5-year-old primiparas;
- 5.5-year-old adult females;
- 10-year-old and older females

The above division proceeds from the normal living conditions of animals. However, in the case of unfavourable weather conditions and poor food the mating and calving period of heifers can be delayed for a year or two (Randveer, 2003).

For comparison we used the skeletons of hoofed animals and horses of the Normal Anatomy Museum of the Faculty of Veterinary Medicine at the Estonian Agricultural University.

For pelvimetric measurements the osseous pelvis was prepared from the muscular tissue and tendons. The pelvic bones were X-rayed both before and after biological maceration. The latter was necessary in order to remove cartilaginous connections between the bones. The maceration was carried out over the period of 3–4 weeks in a thermostat in an aquaous environment.

Findings and discussion

The elk pelvis is drawn-out and narrow. The long body of ilium and coxal tuber are responsible for this kind of shape. By comparison with the bovine animal and small ruminants, the ilium of the elk is somewhat longer, and the greater sciatic notch rises flatly to the ischial spine. The greater sciatic notch is low, lower than the lesser sciatic notch. In the cranial edge of the notch on the wing of ilium there are small bony barbs. The wings themselves have a more horizontal placement than the bovine animal.

The coxal tuber resembles a diamond although it consists of three tuberosities as in the bovine animal: lateral, medial, and cranial tuberosities (*tuberositas lateralis, medialis et cranialis tuberis coxae*). The medial tuberosity is directed slightly upwards and outwards. The coxal tuber is strongly drawn-out laterally, which provides a longer appearance to the entire pelvis. The crest runs on the cranial surface of the tuber; in an adult female elk the tuber is 7.2–8.4 cm in length. Old animals have revealed barbs that are a few millimetres in length on the medial surface of the wing of ilium beneath the cranial tuberosity of the coxal tuber. The iliac spine has thickened in the medial corner and forms a modest round sacral tuber. Both tubers are located lower than the median sacral crest.

On the ventromedial side of the body of ilium there is a bony crest (Figure 1). A. I. Akajevskij (1939) called it the iliopubic crest in the reindeer *(crista iliopubica)*; actually it is located only on the ilium. It begins cranially behind the auricular surface, runs diagonally along the body of ilium, and ends as an eminence on the edge of the acetabulum in its middle section. On the crest there is a small tubercle of the psoas minor muscle as a rough surface. The weakly developed iliopubic crest occurs also in the bovine animal starting with the tubercle of psoas muscle, but it does not reach the acetabulum. On the ventral and lateral surfaces of the body of ilium, cranially from the acetabulum, there are two depressions for the attachment of the rectus femoris muscle (*fovae m. recti femoris*).

The cranial pelvic aperture is vertically oval. In young animals the ventrally demarcating pubis reveals a cranial part on the dorsal pubic tubercle, which is a few millimetres in length and reaches the pubic pecten. The cranial part recedes with age and a furrow forms between the iliopubic eminences (*sulcus pectinis ossis pubis)*. Unlike the elk, the bovine animal retains the pubic spine until an advanced age.

In elk heifers the dorsal and ventral pubic tubercles are of more or less the same length and height. The dorsal tubercle is crest-shaped and is cranially steeper, lowering flatly in the caudal direction. In old animals it disappears completely. The ventral pubic tubercle does not reduce with age.

The iliopubic eminence that occurs on the body of ilium is more massive in older animals. There is a pre-pubic tendon between the opposite eminences. The body of pubis together with its cranial ramus is much larger in diameter than the caudal ramus that helps to form the symphysis.

The obturator foramen is craniolaterally oval and its acetabulum part has a deep finger-wide notch (*incisura foraminis obturati*) for the obturator nerve and the artery. This kind of notch can be found also in deer and roes.

The pelvic floor is flat in the cranial part, but it resembles a U-shaped concavity behind the obturator foramina and rises slightly in the caudal direction. The pelvic floor is the deepest above the cranial ramus of the interischial bone.

In female elks the ischial plate is somewhat wider than in the bovine animal: for this reason, the pelvic cavity is deeper, too. The lesser sciatic notch is deeper than the greater one and much steeper, but both are low in comparison with the bovine animal. The lesser sciatic notch has a furrow (*sulcus incisurae ischiadici minoris*) for the tendon of the obturator internus muscle. Although according to A. I. Akajevskij (1939) the existence of such a furrow is highly characteristic of the reindeer, we have observed it also in the equine pelvis.

According to our data, the angle between the ischial plates is always larger than the angle of the ischial arch (Table 1), but it usually remains an acute angle. The ischial arch always forms an acute angle. In older animals there is a notch two fingers in width in the ischial arch above the symphysis, which is well manifested, for example, in the chital.

The sharp ischial crests are arched in the direction of the pelvic cavity. Like in the horse the narrowest point of the pelvis is the distance between the opposite bodies of ischium behind the acetabulum.

In an adult female elk the ischial tuber is 5.6–6.7 cm in length and it runs almost straight in the dorsoventral direction. One can distinguish in the tuber the cranial, lateral, and caudal tuberosities (*tuberositas: cranialis, lateralis et caudalis tuberis ischiadici*), whereas the latter is located backwards separately from the others. All the tuberosities are rather smooth.

The pelvic symphysis is ventrally strengthened by the interischial bone (*os interischiadicum*) (Nahkur *et al*., 2003) because the symphysis between the opposite rami of the ischial bone and the caudal rami of the pubis remains cartilaginous for a long time. The body of the interischial bone contributes to the formation of the ischial arch; also, the short caudal rami that are attached to the ischium proceed from here. The latter completely join the ischial plates with age. The cranial ramus growing along the pelvic symphysis is longer than the body of the bone. The symphysial crest is weakly developed, has a rather even height, and lowers in the cranial direction.

In a female elk usually the sacrum that forms the dorsal pelvic wall consists of five vertebrae; however, sometimes the first caudal vertebra can be attached to it, too. The wings of sacrum are short and the ventrally open angle that is formed between the wings and the bodies of the vertebrae is sharper than in the bovine animal. The spinal appendages of three cranial vertebrae that form the median sacral crest are grown together, and its dorsal edge has thickened. The spinal appendages of the fourth and the fifth vertebrae are very low and are partly attached. For this reason, the height of the crest decreases dramatically in the caudal direction. The sacrum is more curved than in the bovine animal. It reaches the maximum height on the border between the third and the fourth vertebrae.

In a half-year-old calf weighing about 100 kg the bones are still spongy and smooth. The iliopubic eminence, the tubercle of the psoas minor muscle, and the caudal tuberosity of the ischial tuber are barely noticeable. The notch in the cranial part of the obturator foramen is also weakly developed; the obturator foramen has a craniolateral direction. Apophyseal ossification centers and the interischial bone are absent.

In the course of maceration the three components of the coxal bone became detached in the acetabulum. The ischium forms the greater part of the acetabulum; the pubis has the smallest role (Figure 2). The sacral vertebrae have not grown together as yet.

The ventrally located pit of the rectus femoris muscle on the body of ilium, the furrow in the lesser sciatic notch, and the sacral tuber are better developed. The dorsal pubic tubercle is crest-shaped and has a protrusive cranial part. The shape of the ventral tubercle resembles the tubercle of an adult cow, but it contains an abundant cartilaginous filler mass above the pelvic symphysis.

The angles of the opposite ischial plates and the ischial arch are equally 62 degrees. The cranial pelvic aperture is broader than the caudal one and is almost five centimetres higher.

A year-and-a-half-old elk already has ossification centers on the tubers that are located on separate apophyses and are not joined together. The interischial bone is taking shape on the ischial arch, but during maceration the pelvis halved from the pelvic symphysis. Also, the first sacral vertebra separated from the rest of the sacrum.

The dorsal pubic tubercle is crest-shaped; the ventral one, however, is slightly more flat. The tubercle of the psoas minor muscle, the iliopubic crest, and the notch in the obturator foramen are weakly developed.

The cranial pelvic aperture is slightly broader than the caudal one and is on average two centimetres higher. The angle between the ischial plates and the angle of the ischial arch have increased considerably in comparison with a calf. The measurements of the interischial bone are comparable to those of an adult animal.

The pelvis of a **two-and-a-half-year-old primipara** has developed in breadth and height. The ossification centers on the cranial and lateral tuberosities of the ischial tuber are joined together. The ossification center of the caudal tuberosity and the caudal rami of the interischial bone are not joined together.

The dorsal pubic tubercle is still crest-shaped and sharp; the ventral one, however, is more flat. By comparison with a heifer the iliopubic crest is more developed; the notch in the obturator foramen has formed similarly to an adult female elk, but the tubercle of the psoas minor muscle is barely noticeable.

In comparison with a year-and-a-half-old the shape of the pelvic cavity has not changed considerably, which means that it is evenly oval, narrowing above the ischial crests and the bodies of the ischial bones. The ischial crests are arched towards the pelvic cavity making the upper pelvic cavity narrower in the acetabula and the cranial parts of the obturator foramina. The length of the ischium has not changed much, but the ilium has slightly elongated.

According to the literature, in a **five-and-a-half-year-old elk** the bone growth should have come to an end. The tuberosities of the ischial tuber have grown together with each other and the caudal rami of the interischial bone, but the joints are still noticeable. The same has happened to the coxal and the sacral tubers. In

one pelvis the incompletely developed tuberosities of the coxal and the sacral tubers detached during maceration.

The interischial bone has joined the ischia; also, the cranial rami of the pubis have joined together. The ischial symphysis still reveals a small slit between the rami of the ischial bone.

The dorsal pubic tubercle has flattened and a furrow has formed on the pubic pecten. On the ventral pubic tubercle an osseous bridge has formed above the pelvic symphysis. The iliopubic crest is developed and reaches the joint cavity of the acetabulum. There is an osseous crest on the medial surface of the body of the ischium that runs semi-slantingly from the lesser sciatic notch to the cranial end of the obturator foramen.

The transverse diameters of the cranial and caudal apertures are almost equal. The caudal pelvic region has become broader; also, the height of the pelvic cavity and the length of the pelvic floor have increased. The development of the interischial bone contributes to the growth of the latter.

There are small pointed osseous barbs on the medial surface of the wings of ilium above the coxal tubers.

The pelvis of a **10-12-year-old elk** has not changed much in comparison with the previous age group. The dorsal surface of the pubis is smooth and flat. The pelvis symphysis has grown together (Figure 3), on the ventral surface one can see a furrow between the ischium and the rami of the pubis. The deep furrow that has formed on the caudally arched pubic pecten is located ventrally from the iliopubic eminences. The cranial edge of the ventral pubic tubercle protrudes from the pubic pecten and is more accentuated. The thickness of the pubic rami has not changed much with age.

The cranial ramus of the interischial bone has elongated although it reaches only the caudal third of the obturator foramen as in younger animals.

The cranial transverse diameter is smaller than the caudal one, but the cranial aperture has remained higher than the caudal one. The overall length of the pelvic floor has not increased anymore.

Summary and conclusions

A limitation of the study is that in comparison with domestic animals the age of a pelvis of a female elk can be determined only roughly and the obtained material is uneven. The growth and reproduction of elks are closely linked with the circumstances whether particular years have been favourable for them or not (climate, food, etc.). For this reason, the pelvises of same-age animals may reveal considerable variation in size. Nevertheless, one can claim that the development of the pelvis of a female elk and the ossification of the pelvic symphysis begins rather later and therefore lasts longer. The features that are characteristic of a female pelvis become apparent by sexual maturity, but the development of the bony structures that are necessary for the attachment of smaller muscles lasts at least until age six. An exception is the dorsal pubic tubercle that has almost completely reduced by that time. However, also the apophyses and muscular lines of the pelvis of an old female elk are smaller than, for example, the corresponding structures of a bovine animal. Thus, one can agree with the claim by L. Bartosiewicz (1987) that in the bovine animal the body muscles are better developed than in the elk. At age three the ossification of the pelvic symphysis is still incomplete, at age six the cranial part of the pelvic symphysis and the caudal part of the ischial symphysis are ossified, and at age ten the entire symphysis has grown together.

A peculiar age-related change in the pelvis of a female elk is that the pubic pecten shifts together with the reduction of the dorsal tubercle. While in young animals the latter is crest-shaped and protrudes cranially, by age six it is reduced. The pubic pecten has shifted like an arc in the caudal direction, and a furrow has formed between the iliopubic eminences. With age it is the ventral pubic tubercle that is cranially protrusive. At the same time the distance between the acetabula increases, but the diameter of the cranial ramus of the pubis at the symphysis does not decrease remarkably, being 3.6 cm in a six-month-old calf, on average 3.7 cm in a year-and-a-half-old female elk, and 3.1 cm in an old elk. While in the bovine animal the dorsal pubic tubercle is retained in some cows even in the old age (Jalakas, 2004), then it had degenerated in all the elk pelvises that we studied.

Some structures of the pelvis of the female elk develop at the arrival of sexual maturity, and their proportions remain more or less the same throughout their entire life, for example, the size of the acetabulum, length of the obturator foramen and the body of ilium, diagonal measurement, etc.

With age the pelvis of the female elk increases in height in the cranial part and in width in the caudal part. It is likely that in older age it helps to compensate the rigidity of the pelvis symphysis at delivery. Also, it is important to note that in the female elks the sacroiliac joint is not ossified in the old age – the sacrum became detached during maceration in all cases. According to the literature, older female elks have more often multiple births, the delivered calves weighing less and being smaller – the average mass of a calf at delivery is 11–16 kg (MacDonald, 2002). Therefore, they have an easy delivery. The primiparae give birth to a single calf, but in their case the elasticity of the pelvis symphysis helps to increase the pelvic cavity.