The udder linear appraisal of dairy goat and genetic correlation

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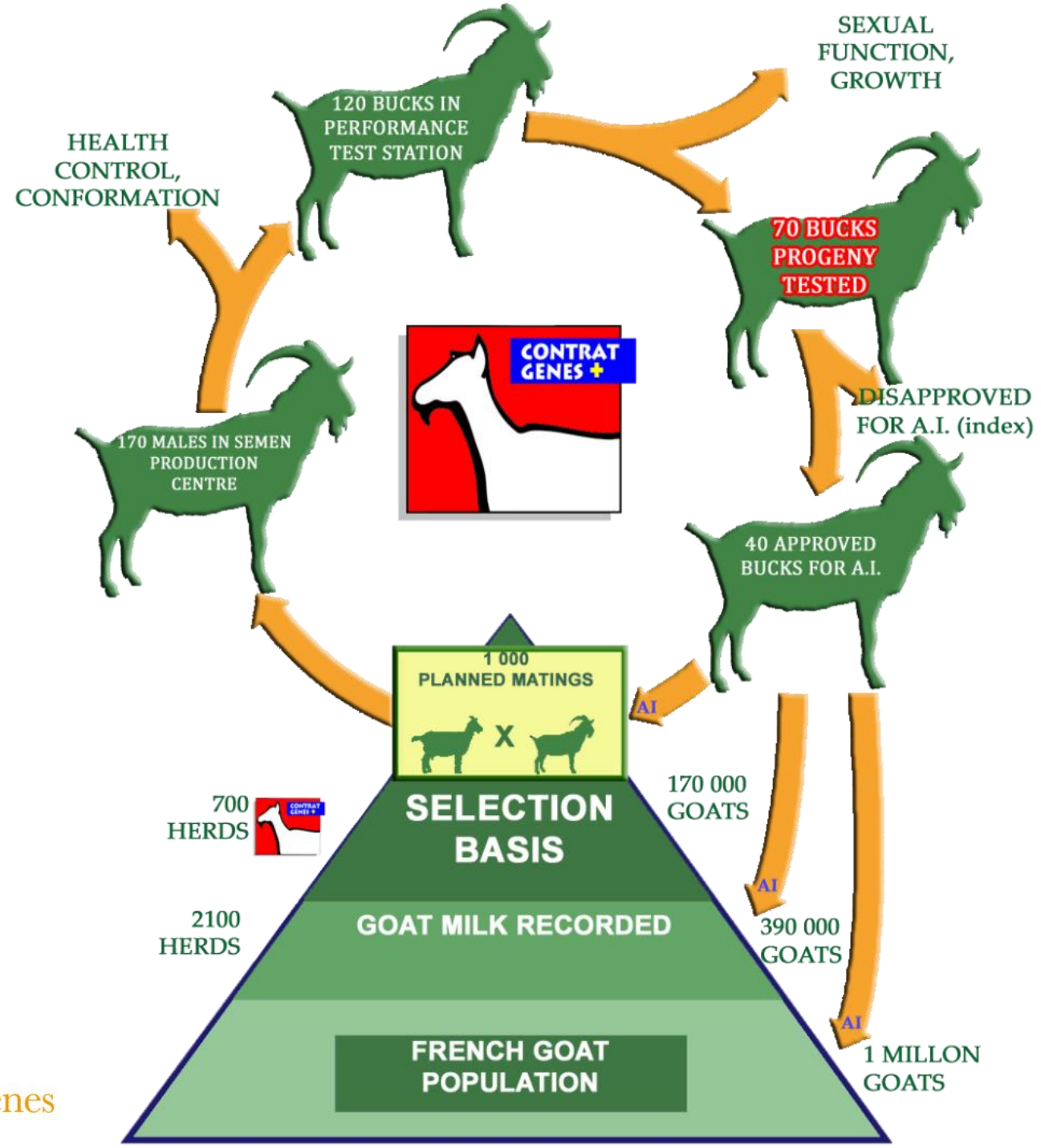
- Advisor: Shii-Wen Roan, Ph.D.

- Date: 2014/4/9

Outline

- The udder linear appraisal system in France
- Udder and parity, milking month, corelation

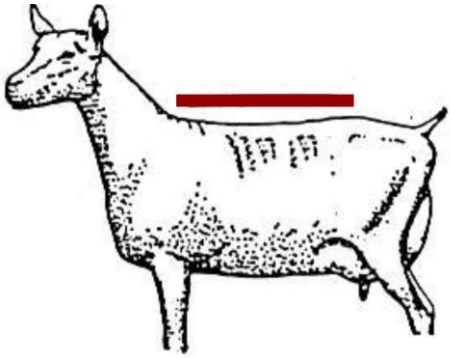

SEXUAL FUNCTION, GROWTH
120 BUCKS IN PERFORMANCE TEST STATION
HEALTH CONTROL, CONFORMATION
70 BUCKS PROGENY TESTED
CONTRAT GENES +
DISAPPROVED FOR A.I. (index)
170 MALES IN SEMEN PRODUCTION CENTRE
40 APPROVED BUCKS FOR A.I.
1 000 PLANNED MATINGS
AI
X
700 HERDS
SELECTION BASIS
170 000 GOATS
AI
2100 HERDS
GOAT MILK RECORDED
390 000 GOATS
AI
FRENCH GOAT POPULATION
1 MILLON GOATS

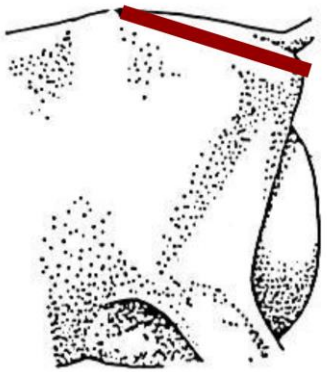
Capgenes

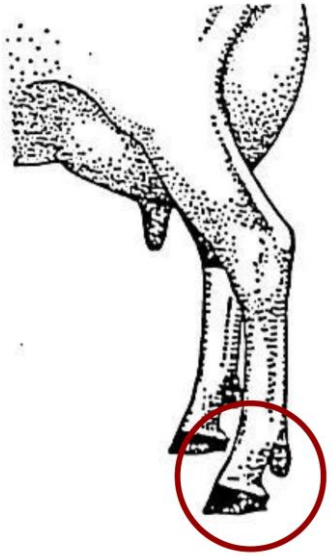
Goat Morphology Appraisal

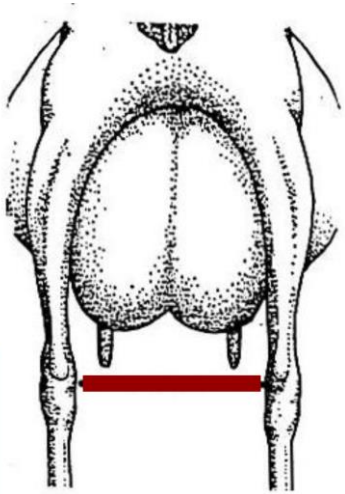
Morphological Appraisal System

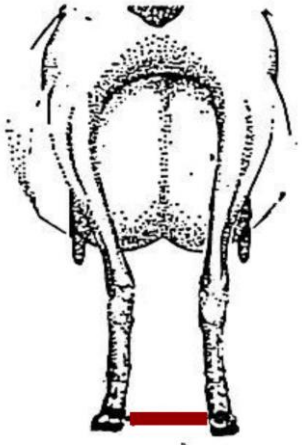
- Same Linear Appraisal for Alpine and Saanen with a variation of 9 notes (1 to 9)
- 11 kind of criteria to appreciate or measure
- Morphogical appraisal of young goats, selected mothers and farm reproductive males





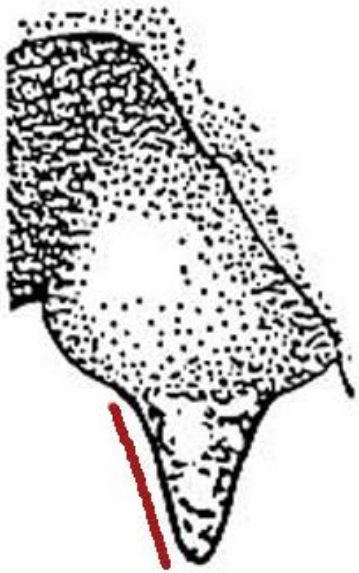




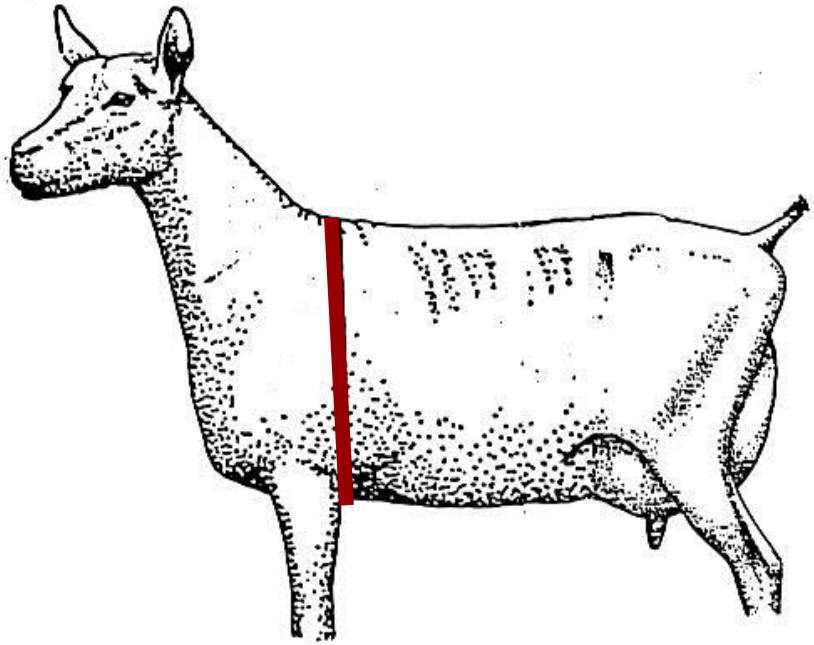


2 Measures

TEAT LENGTH

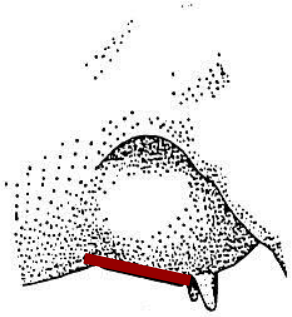


CHEST

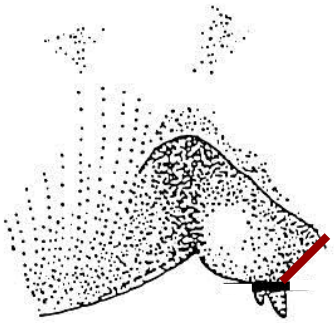


Morphological Appraisal Description of *Udder*

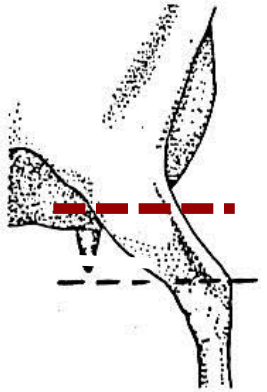
FRONT



PROFILE

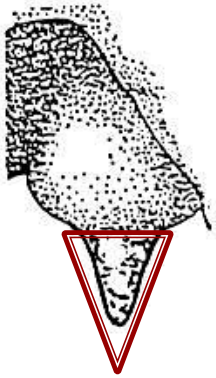


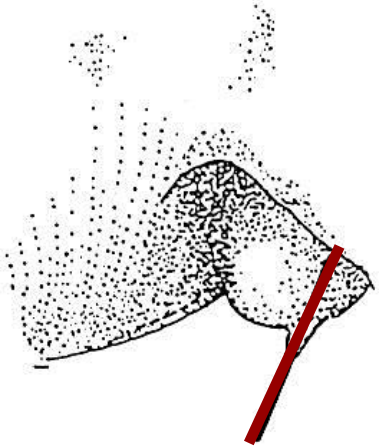
FLOOR POSITION

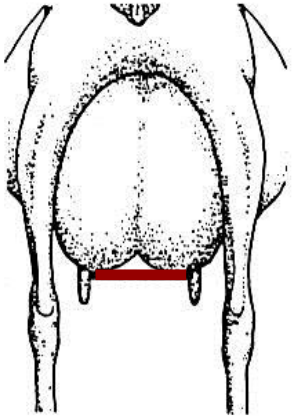


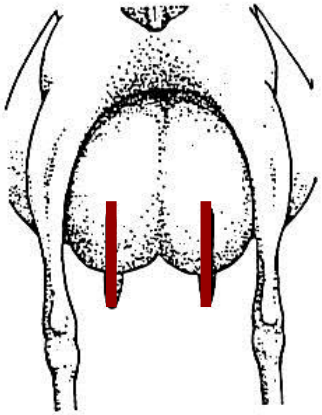
Morphological Appraisal Description of Teats

FORM INCLINAISON IMPLANTATION ORIENTATION



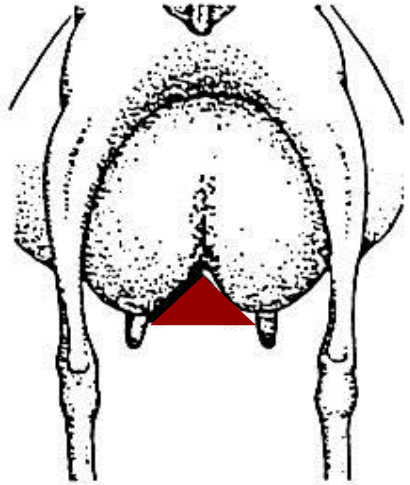






Morphological Appraisal Description of *Rear Udder*

FORM



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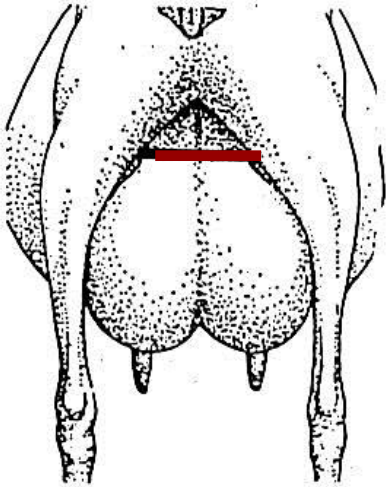
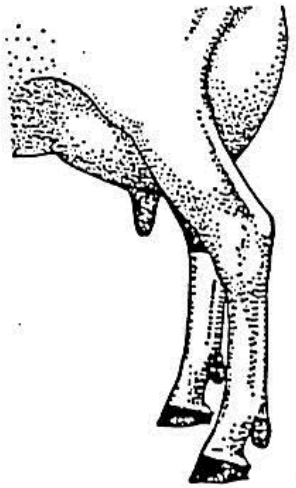
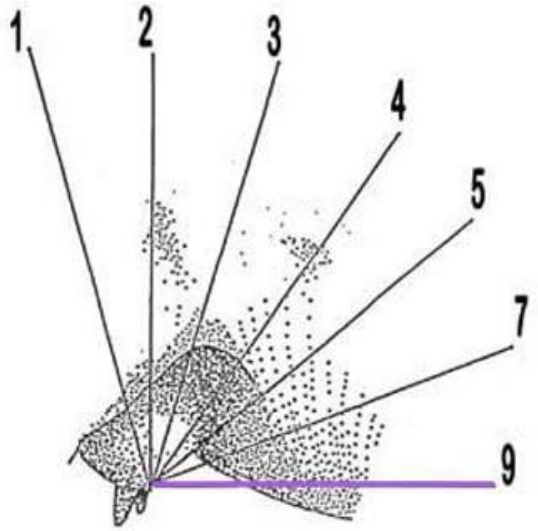


TOES





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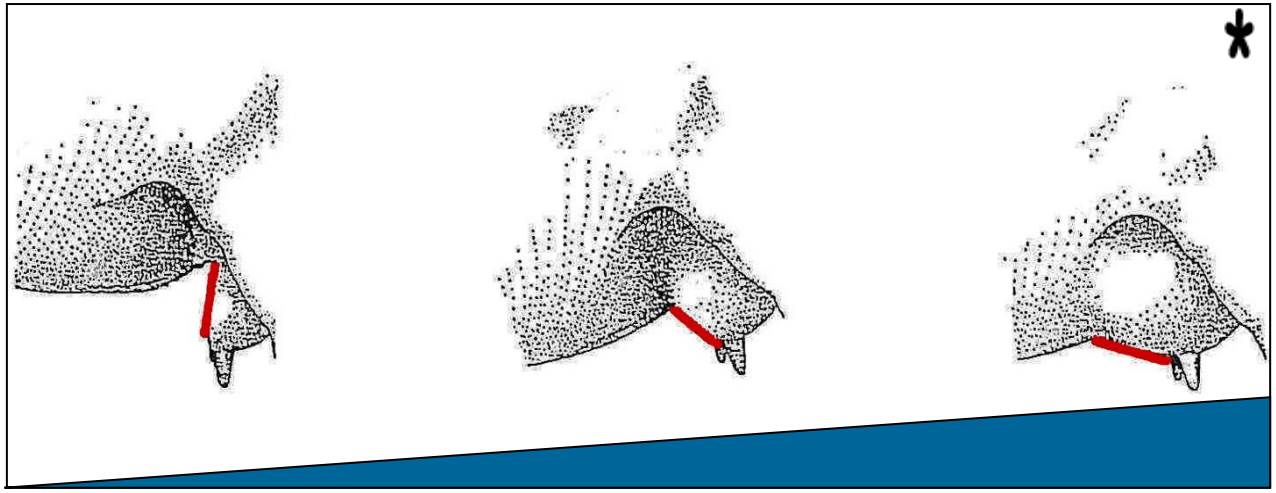

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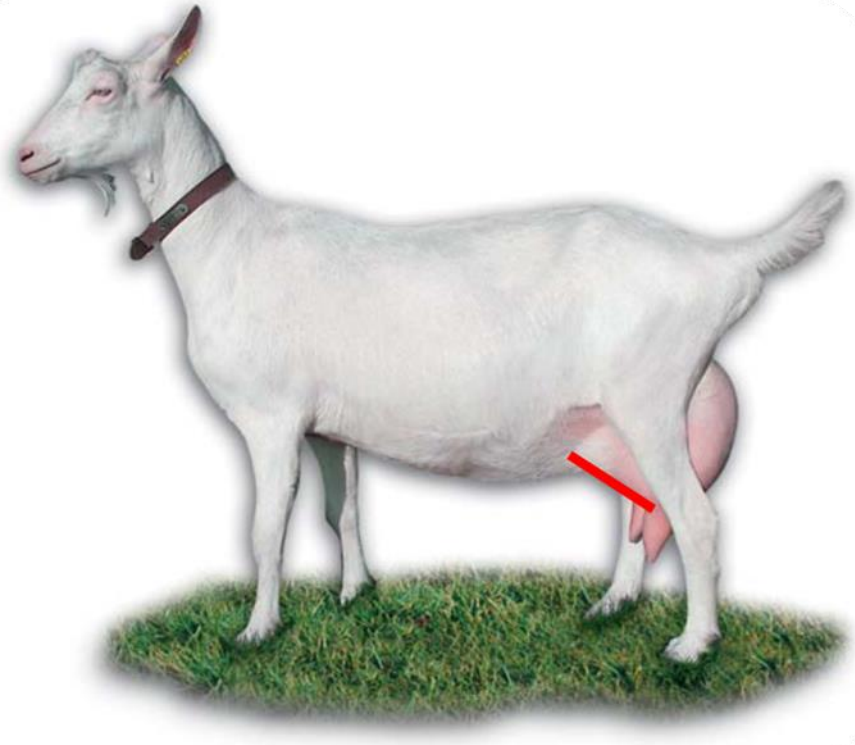

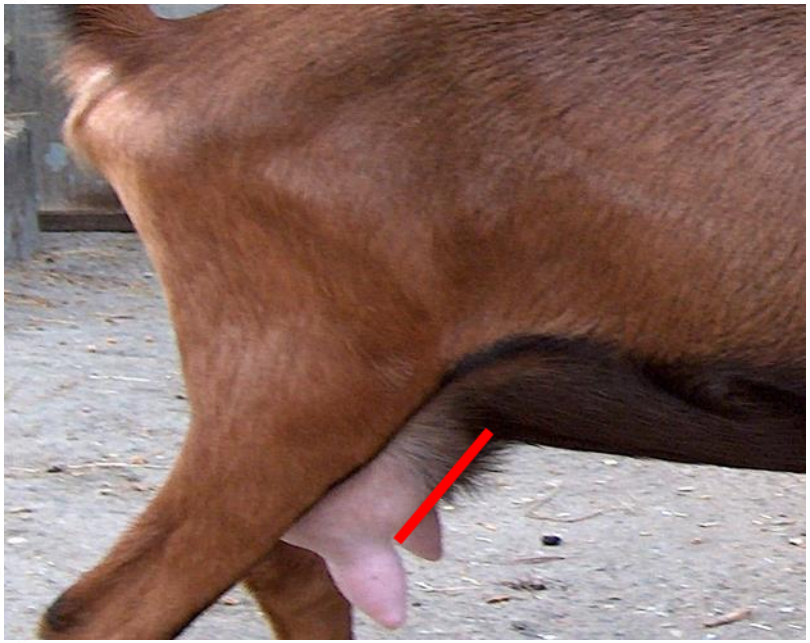

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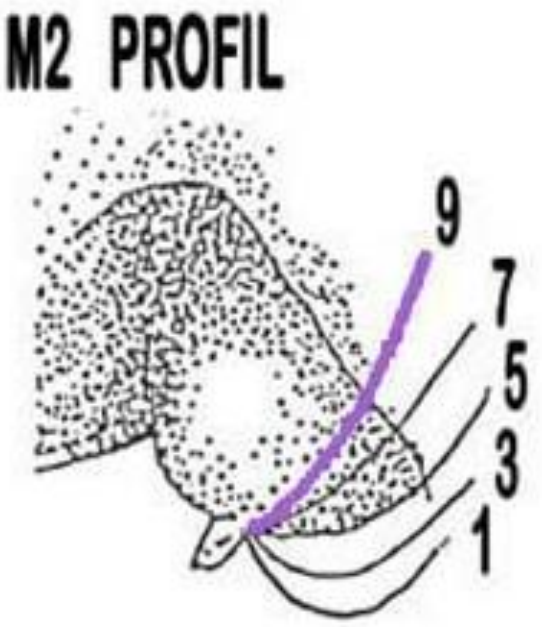

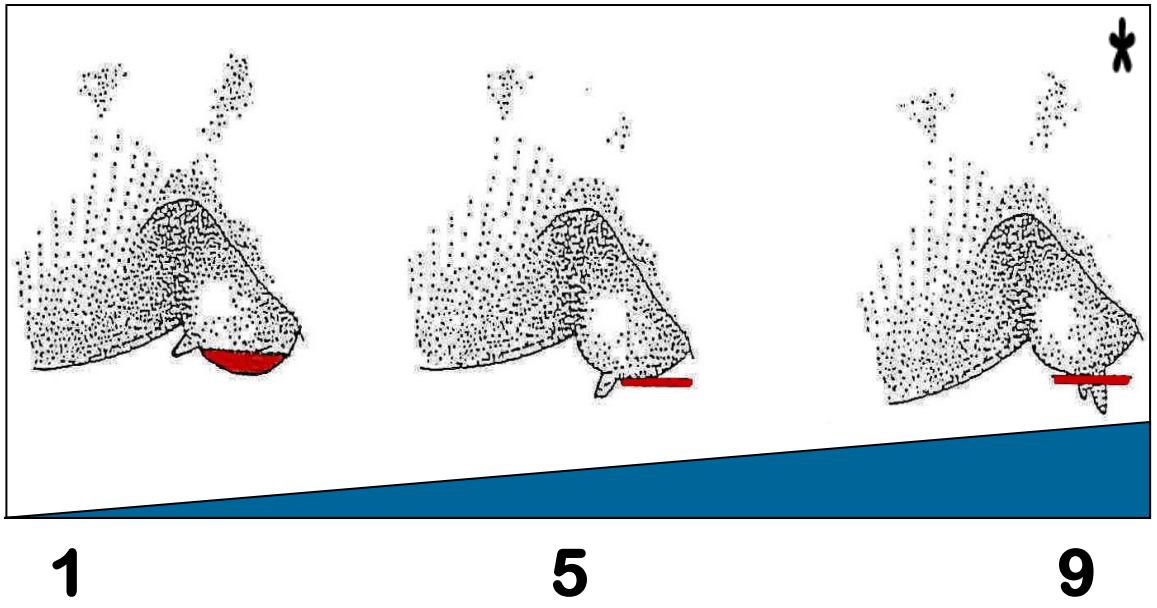

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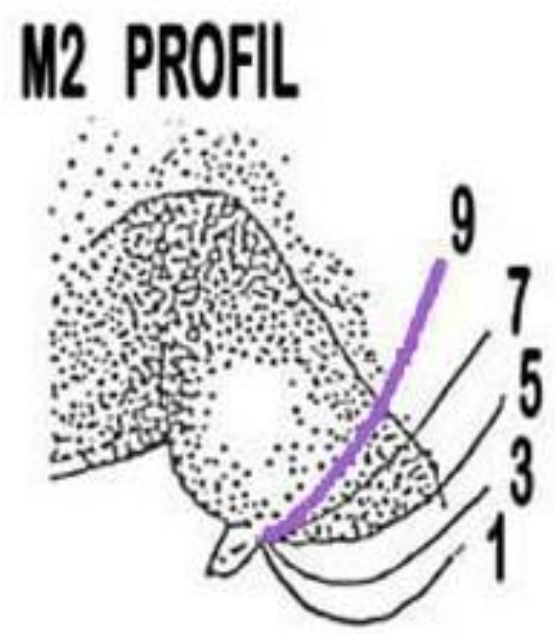

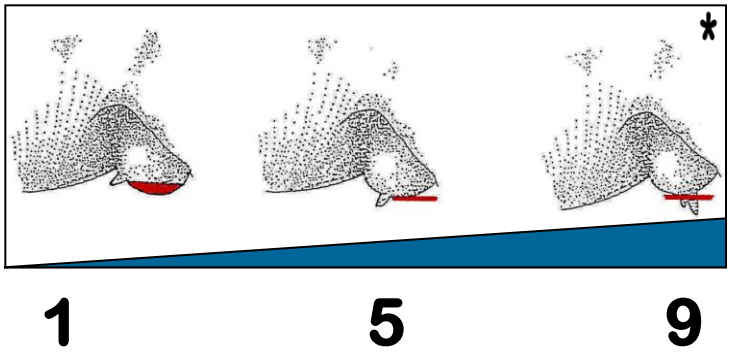

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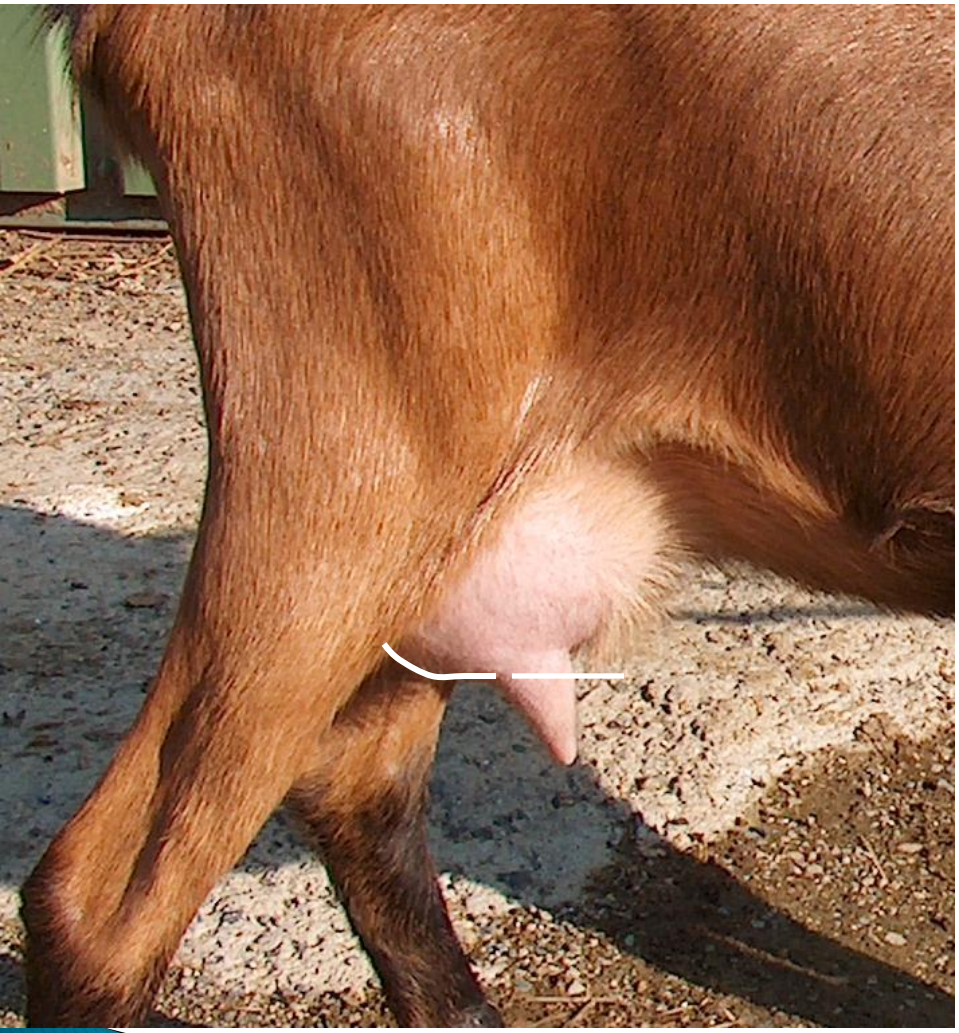

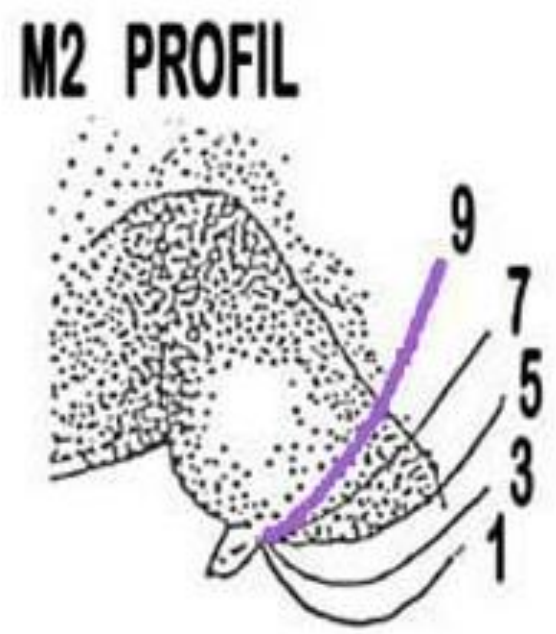

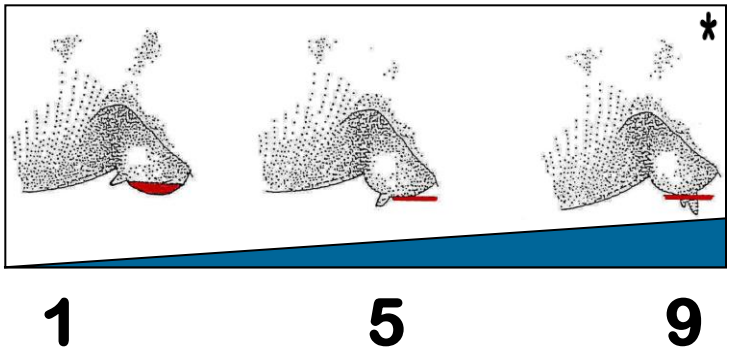

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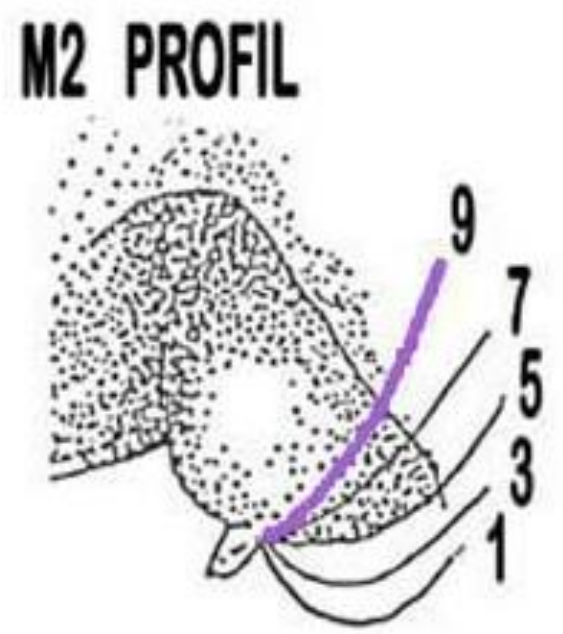

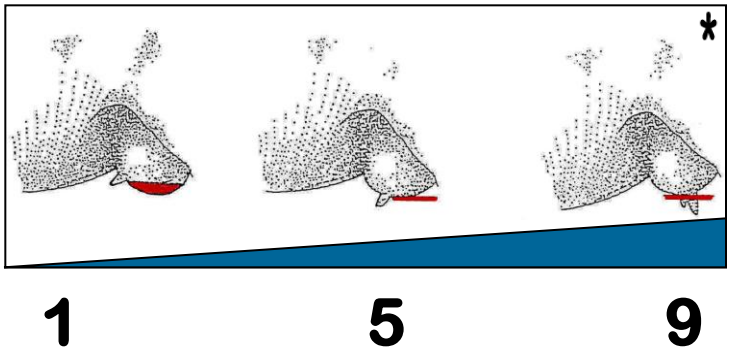

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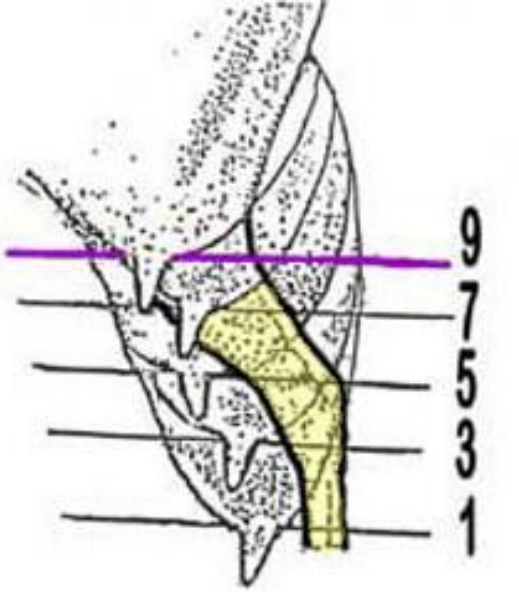

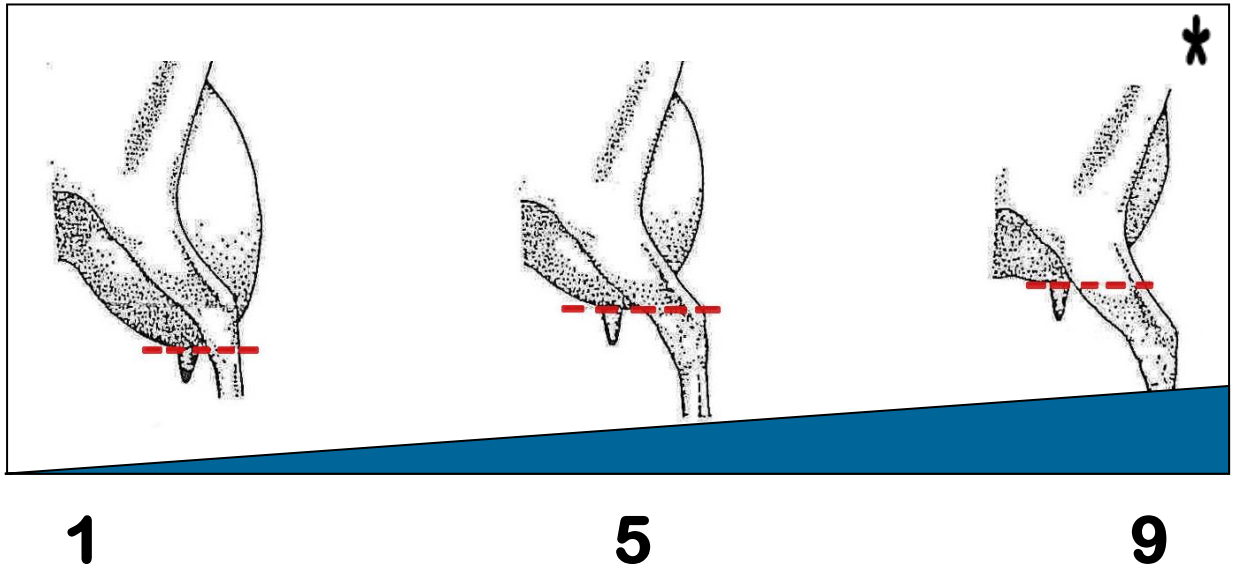

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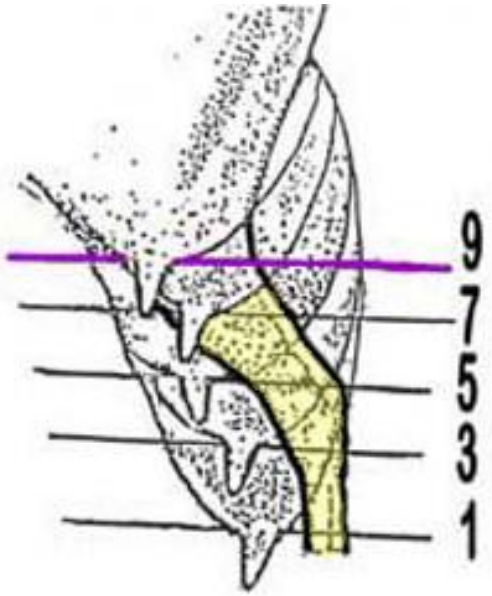

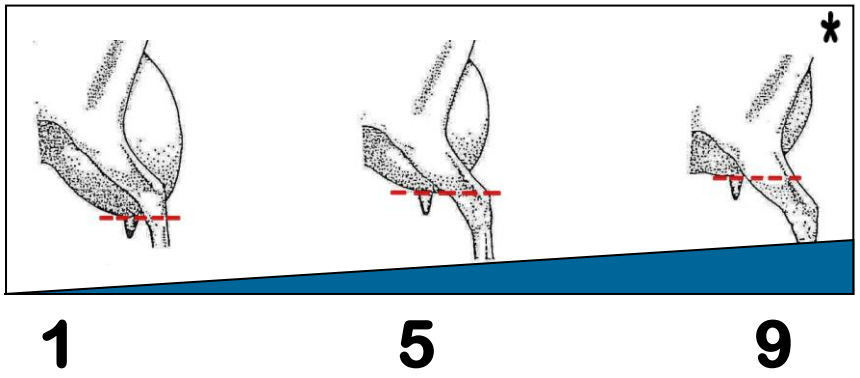

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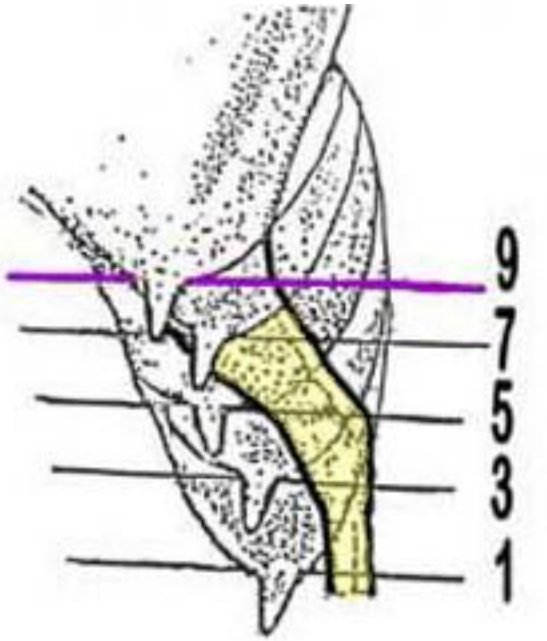

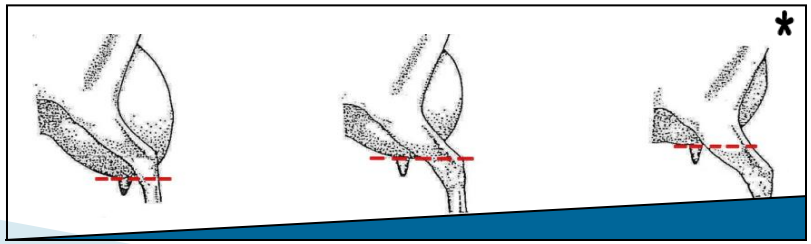

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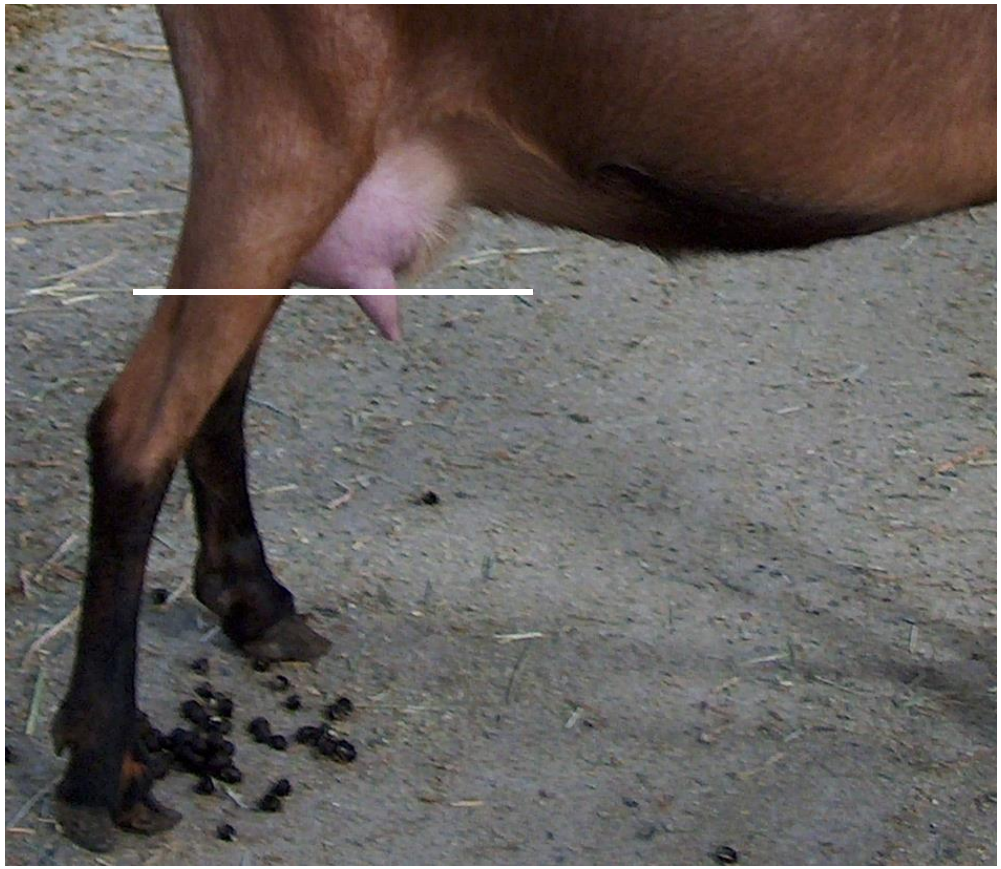
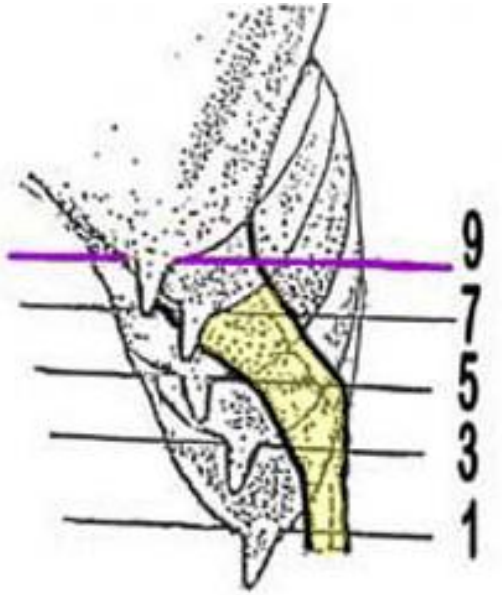
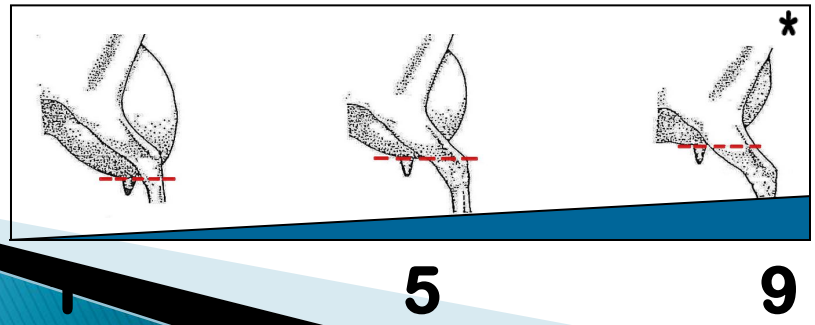
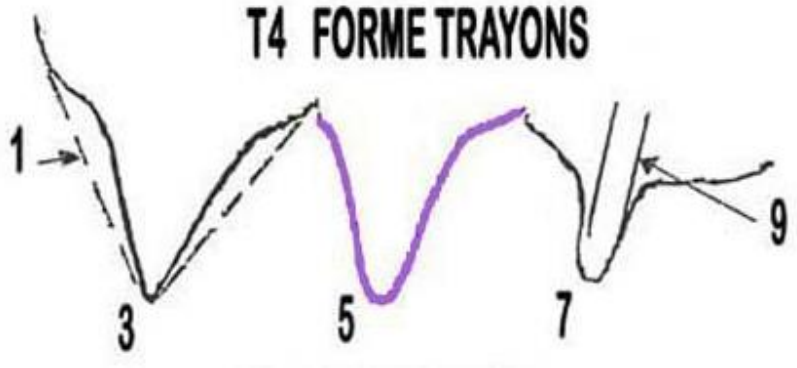
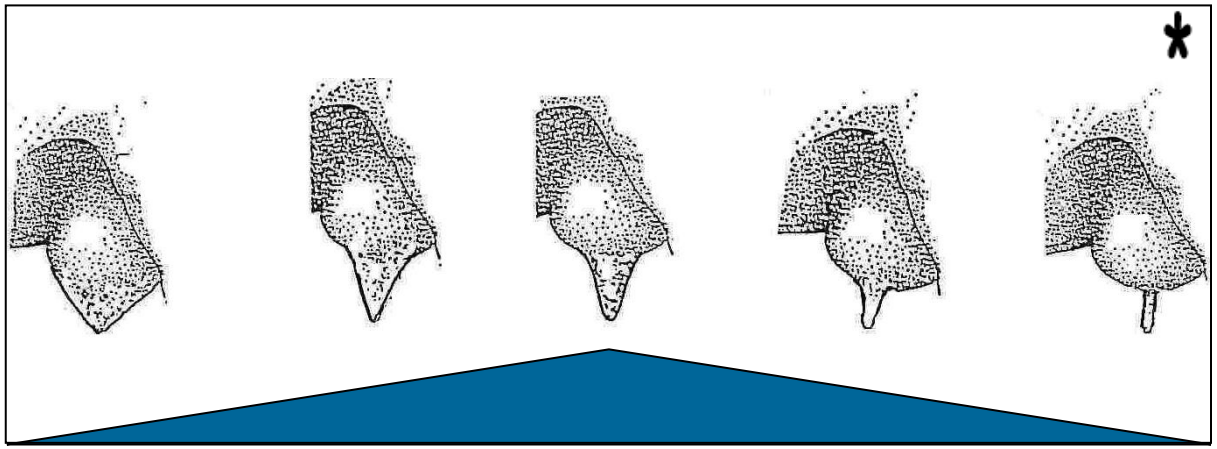






TEAT FORM





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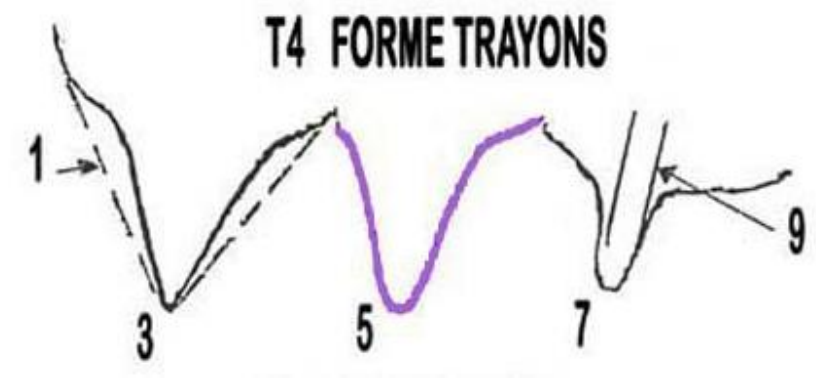

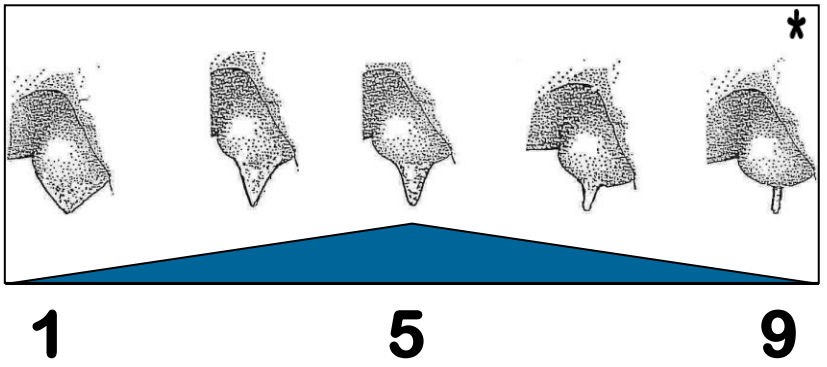

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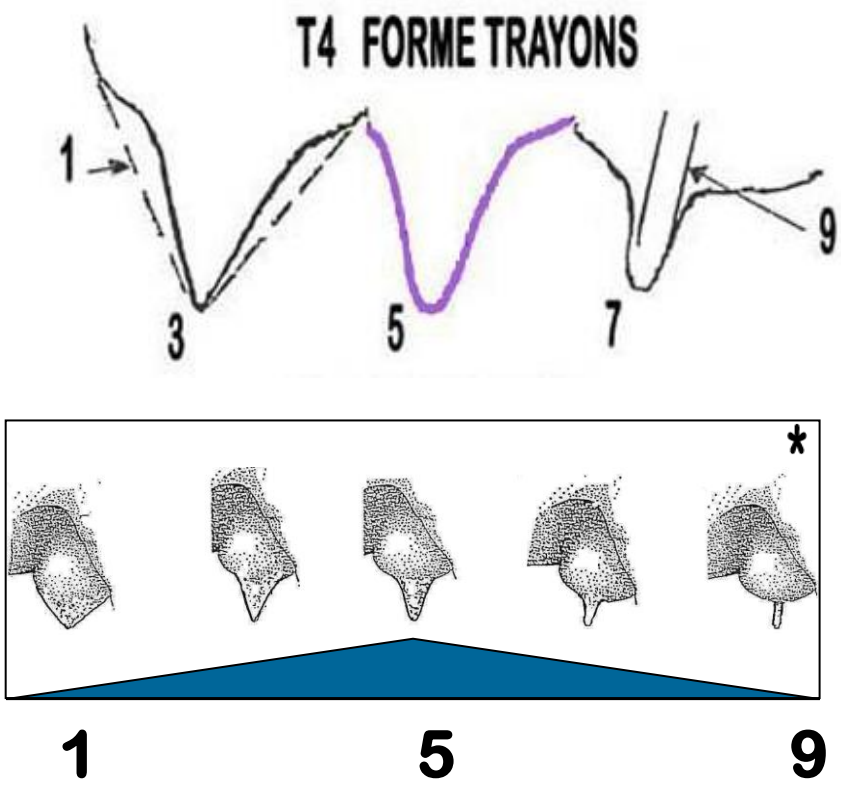

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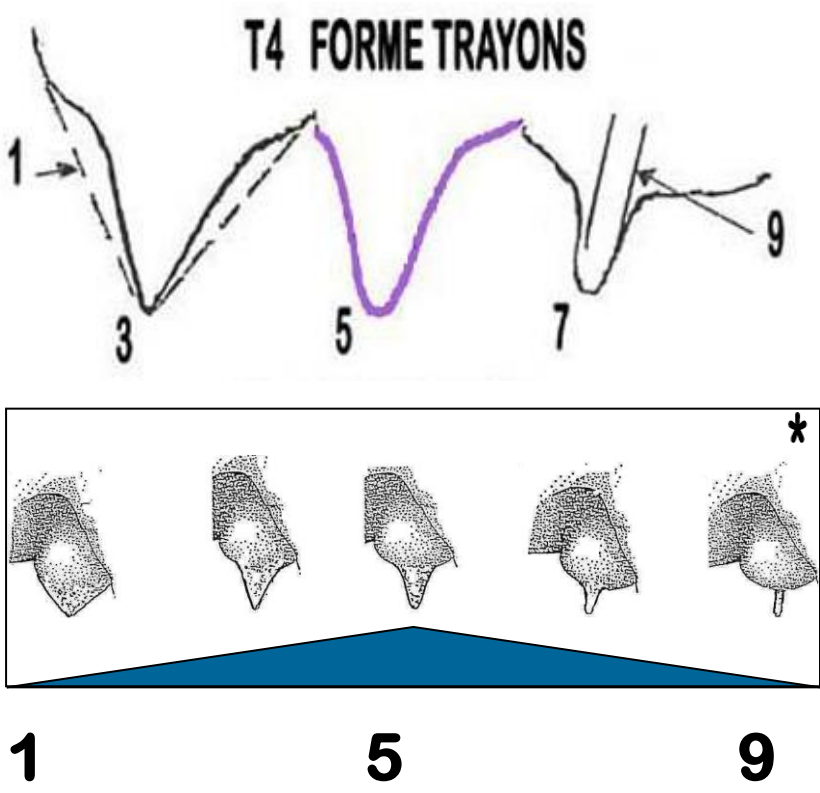
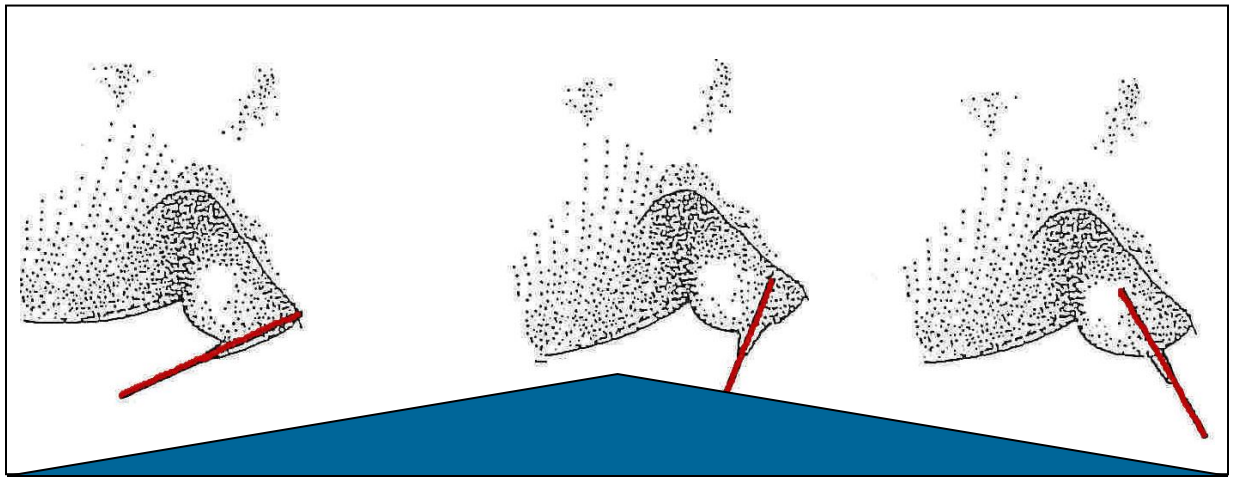


INCLINAISON



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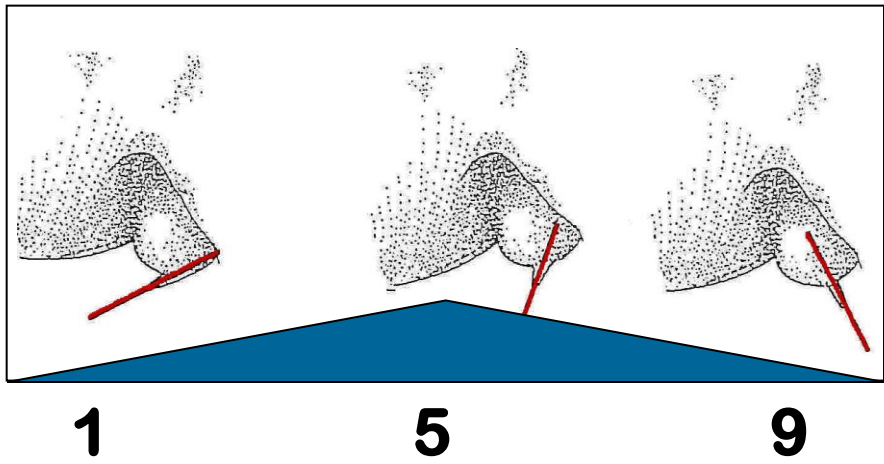

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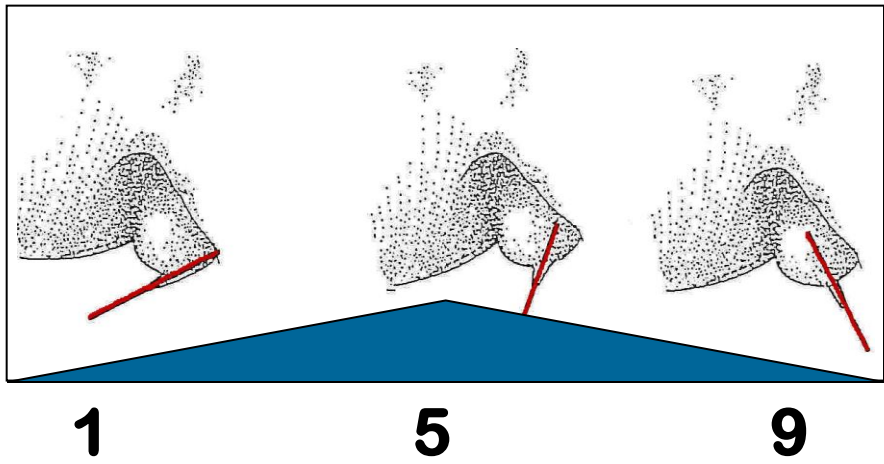

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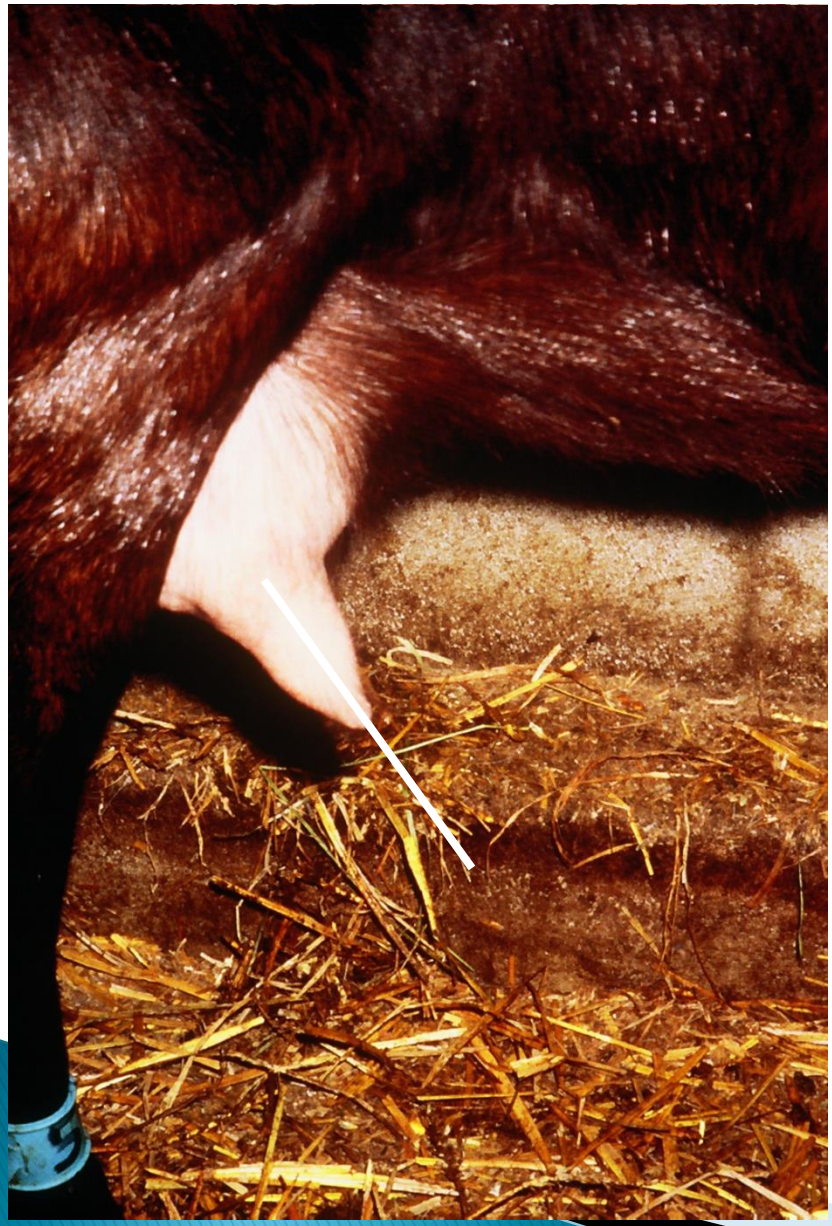
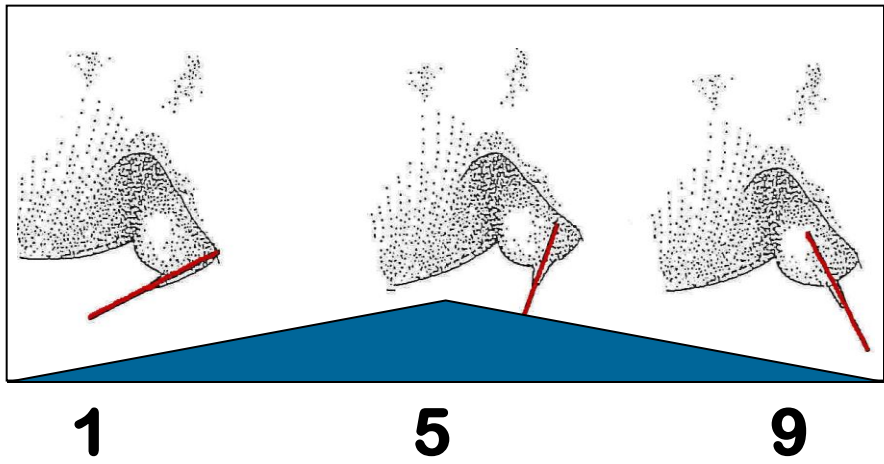
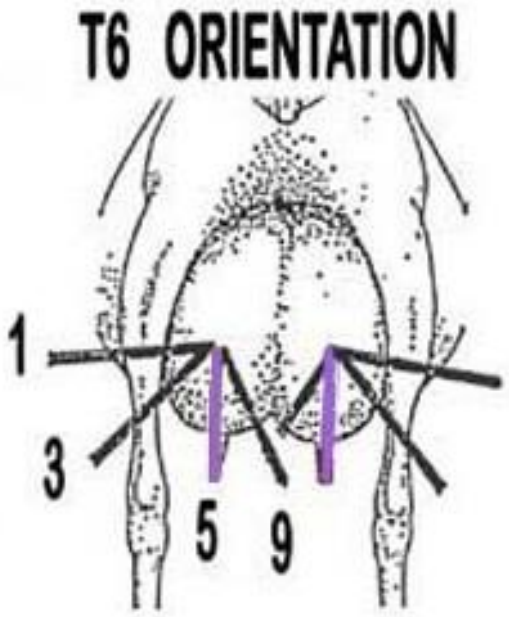
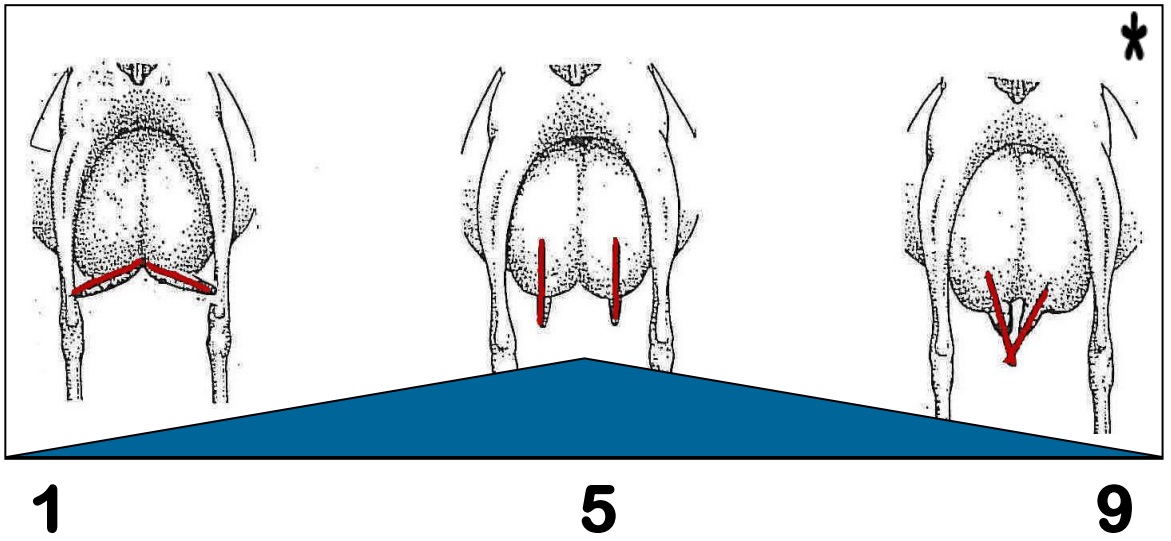




ORIENTATION





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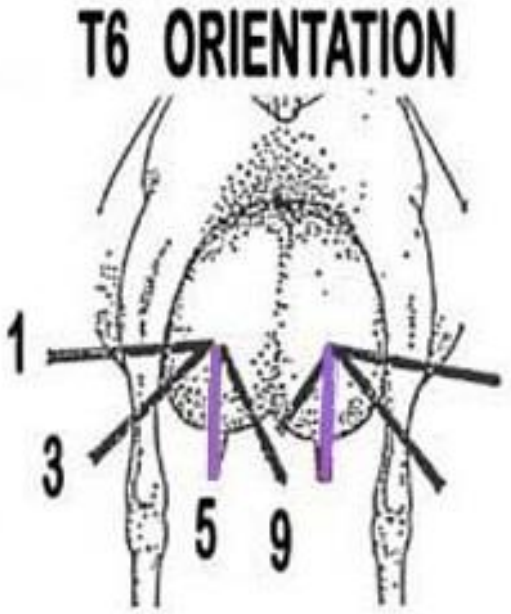

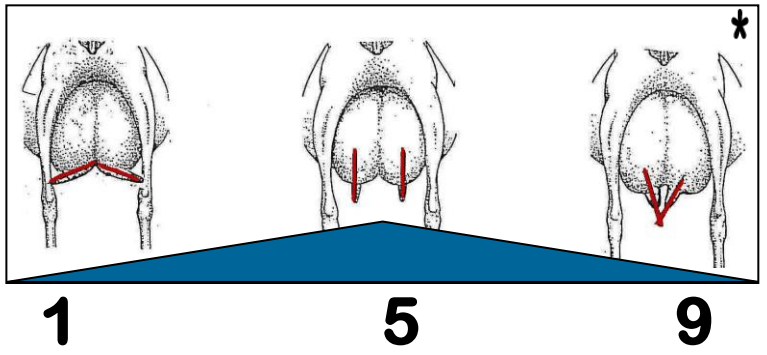

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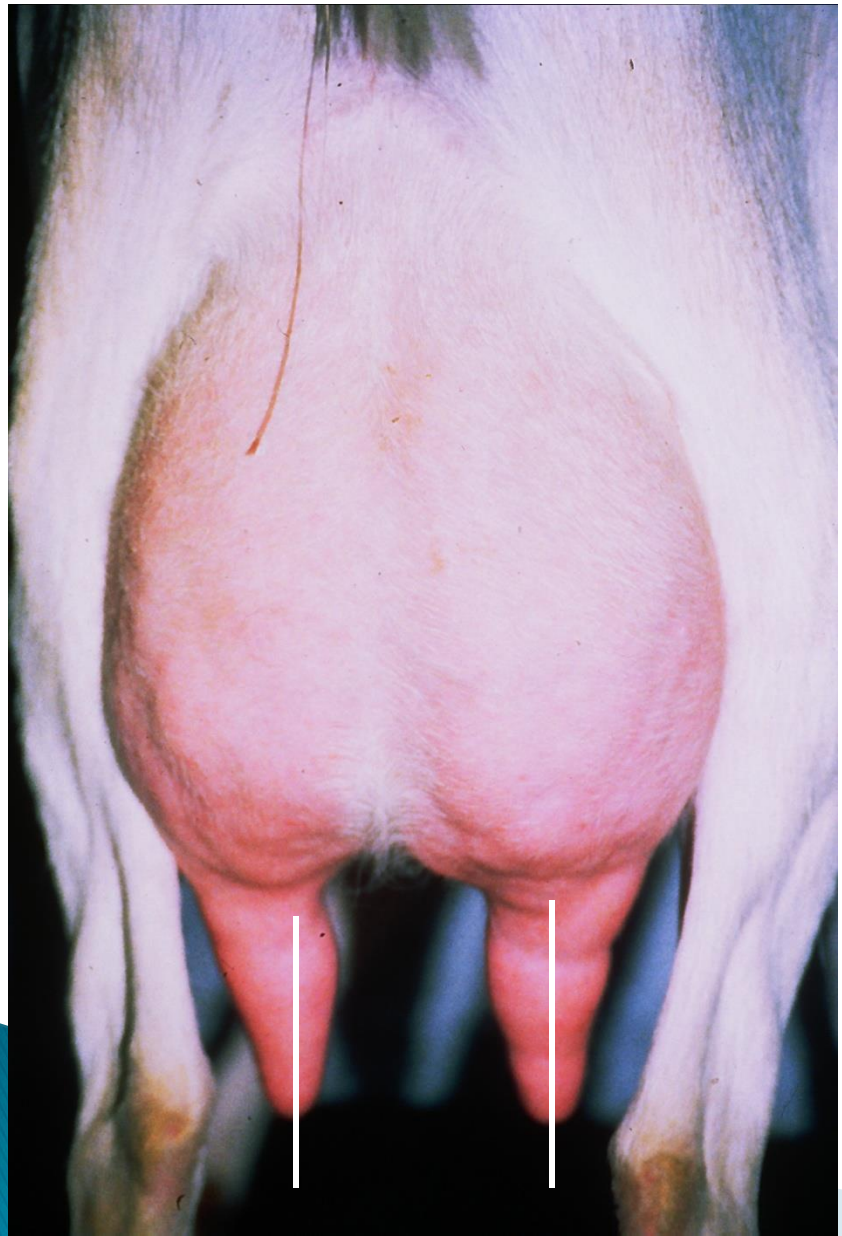

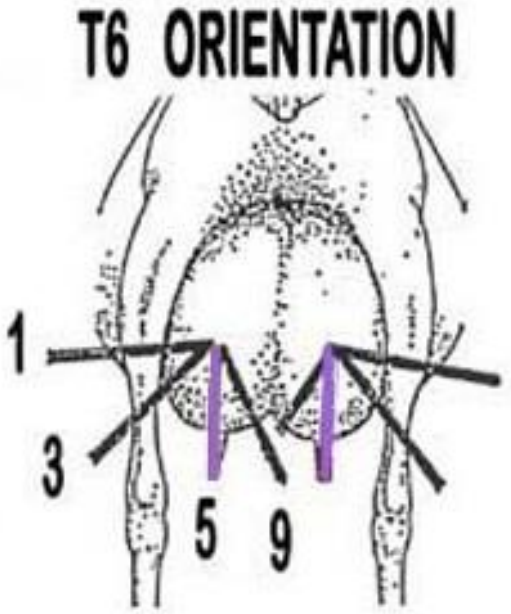

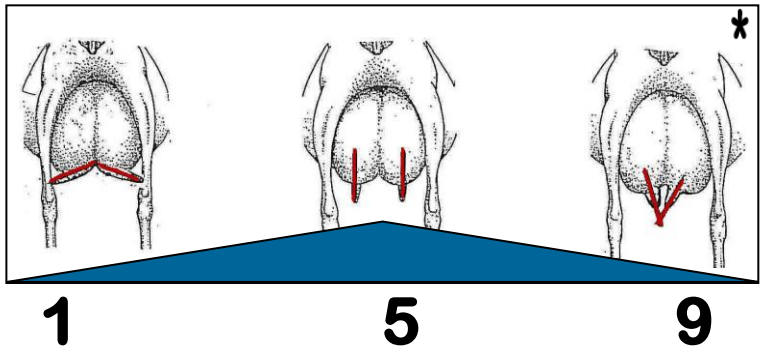

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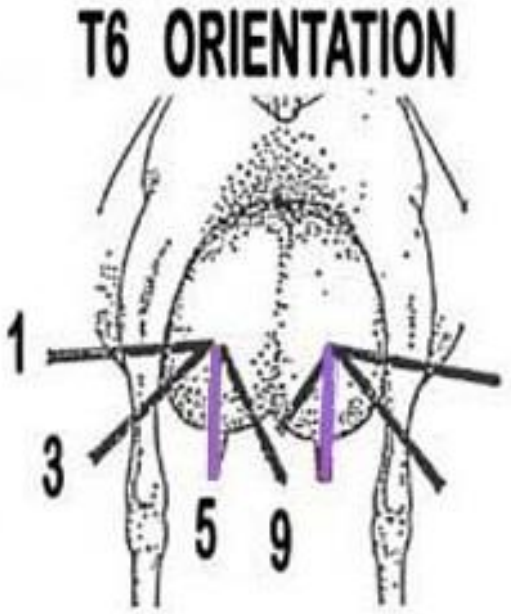

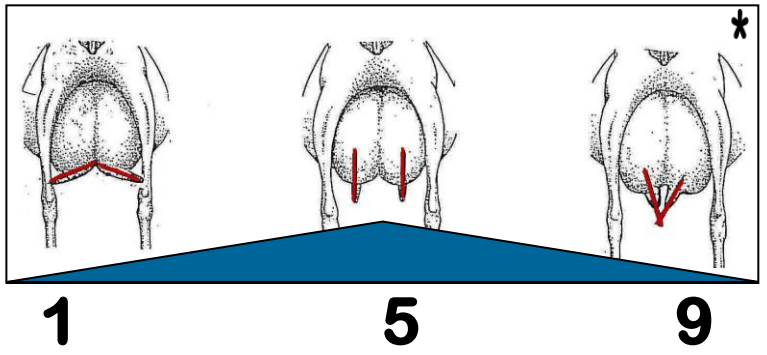

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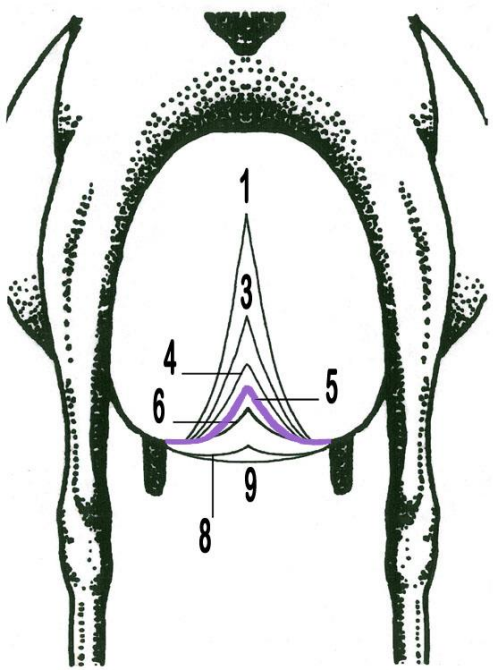

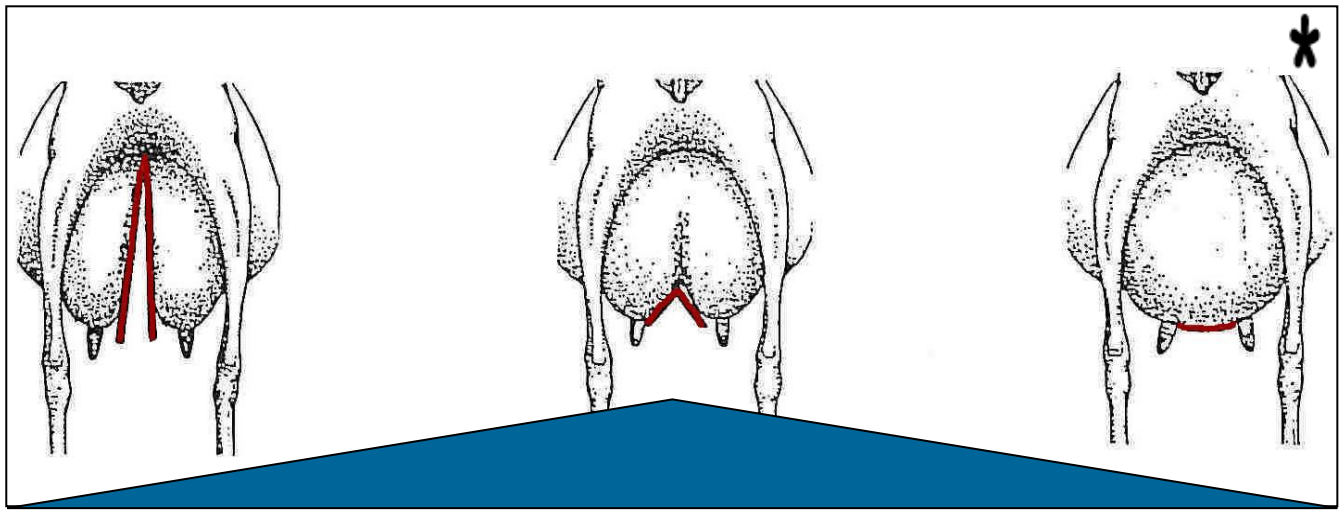

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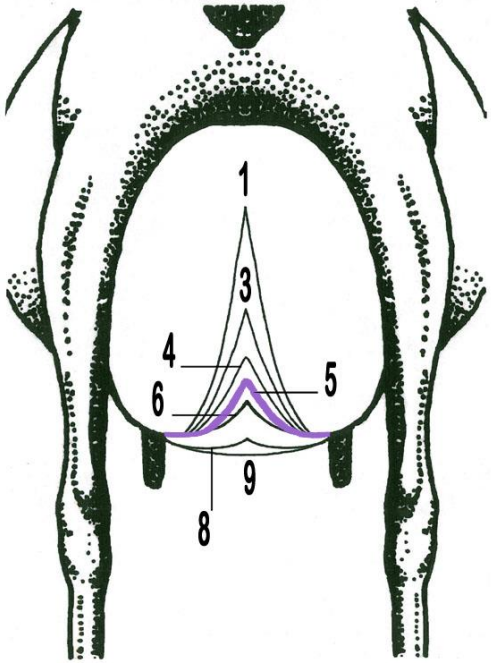

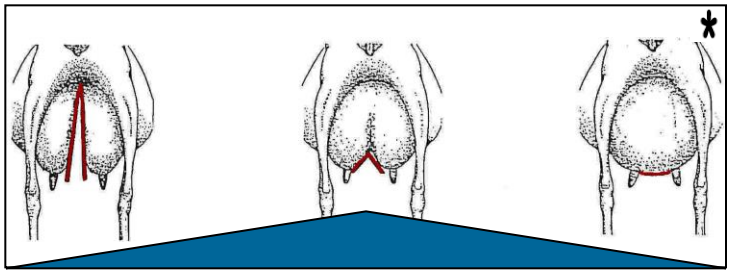

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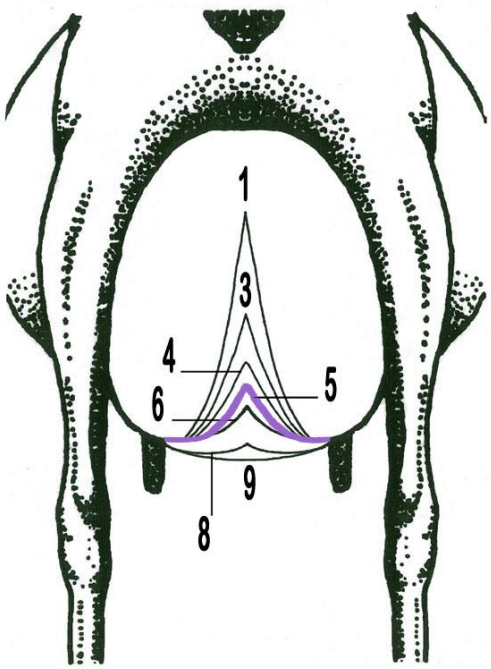

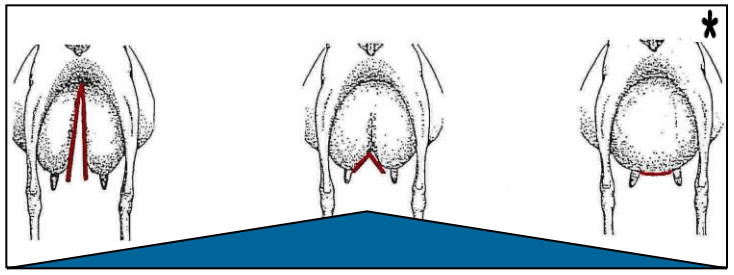

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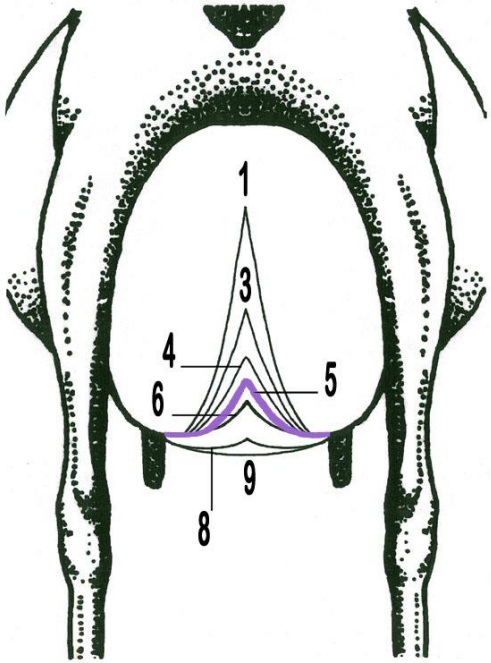

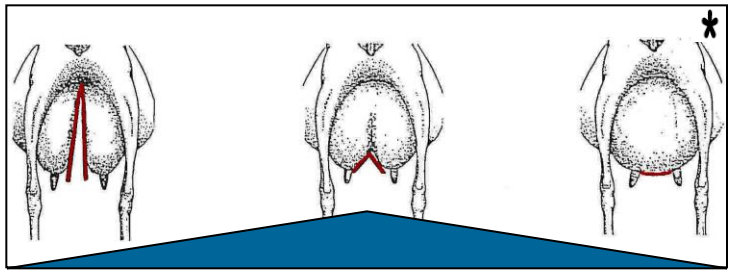

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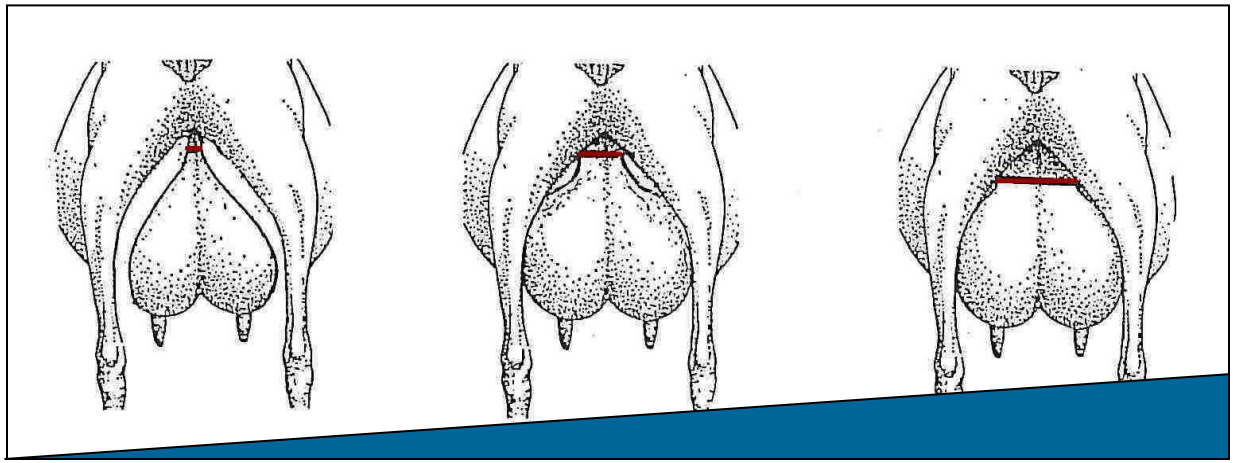

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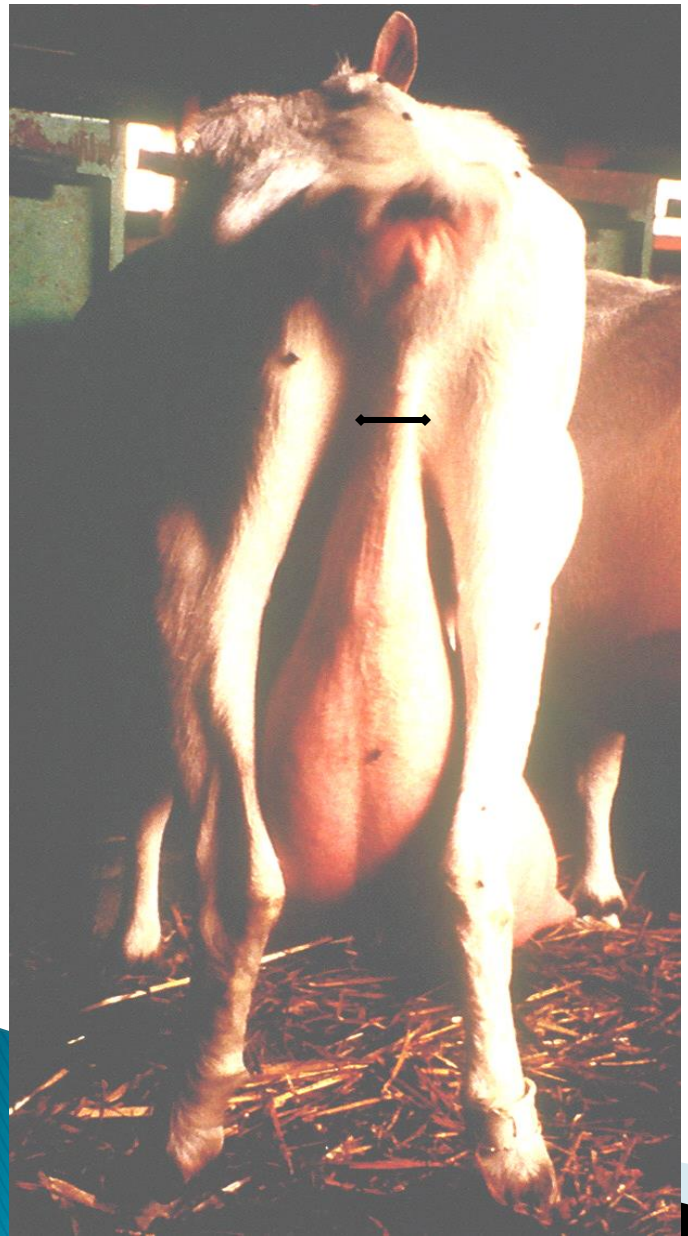

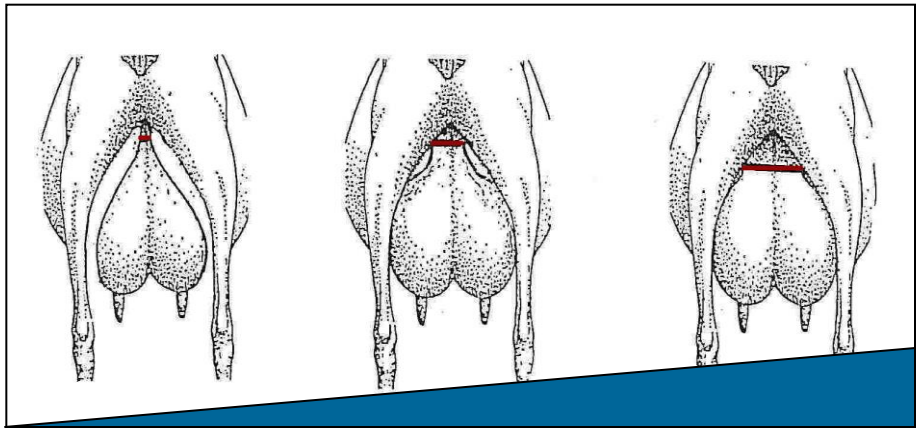

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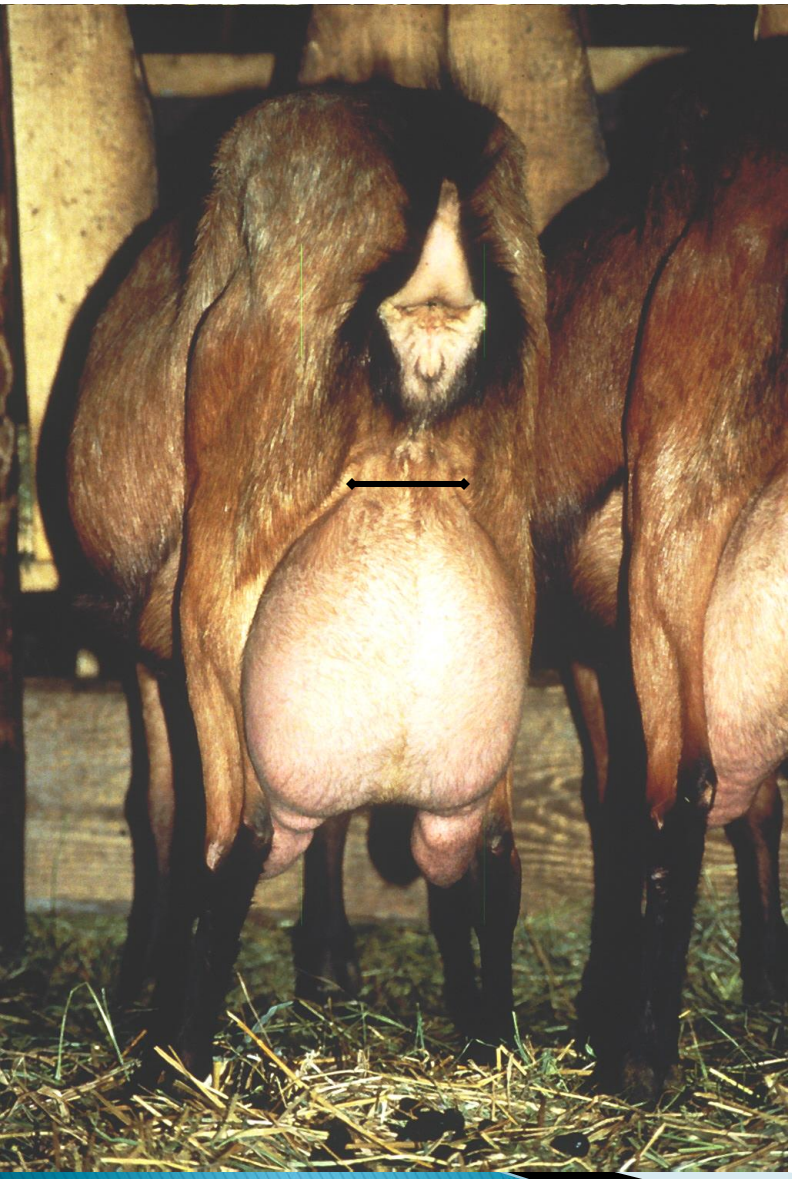

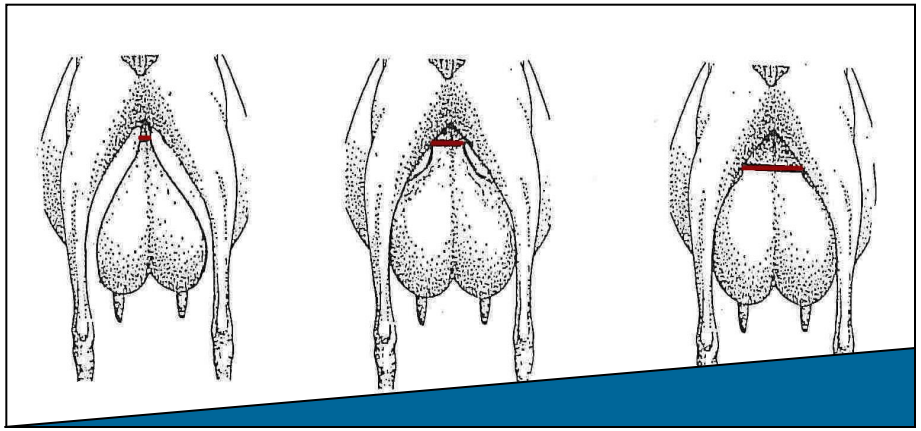

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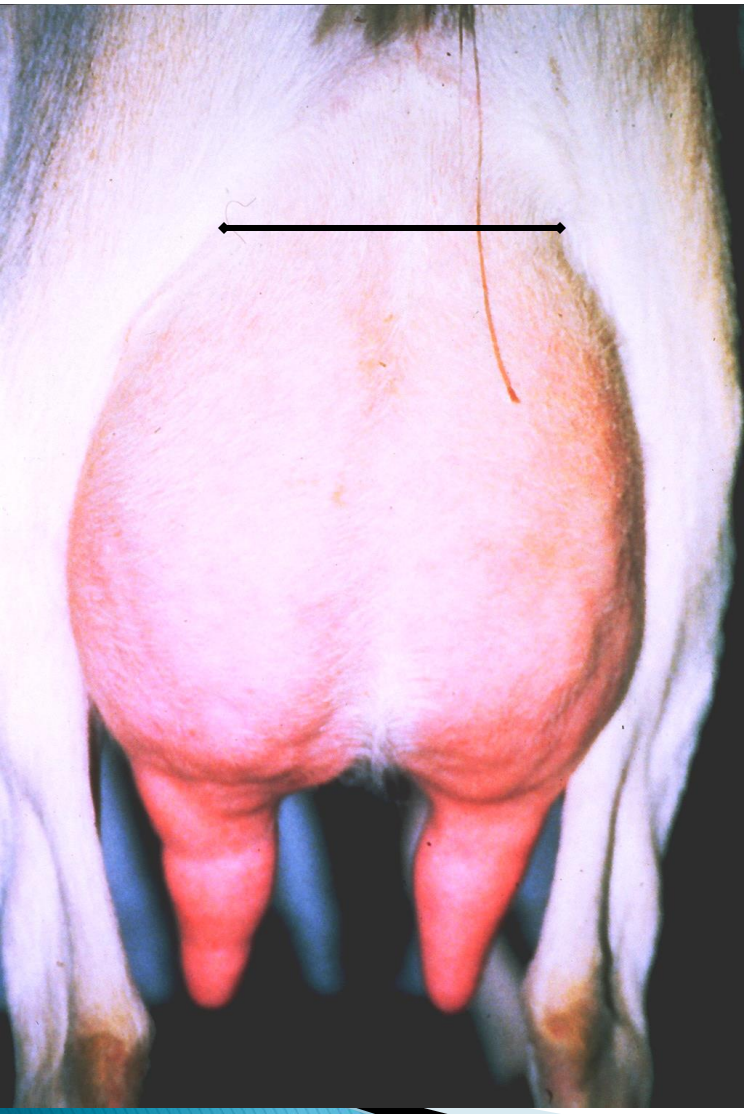

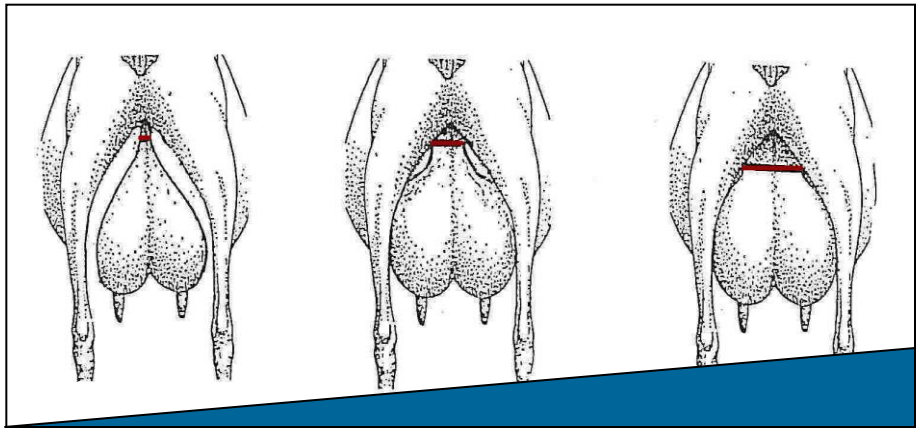

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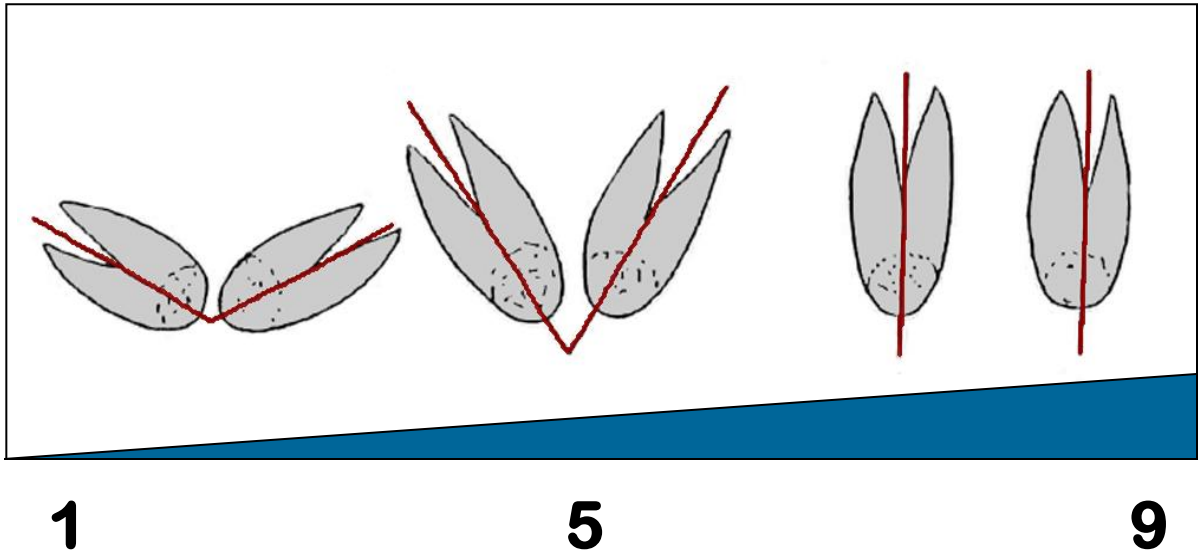

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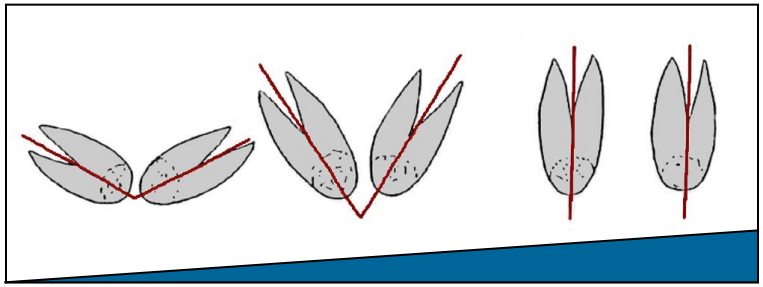

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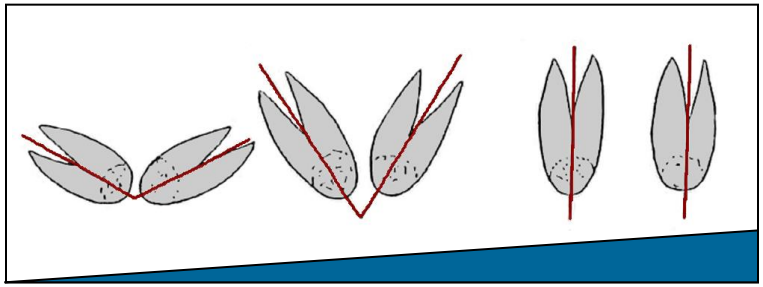

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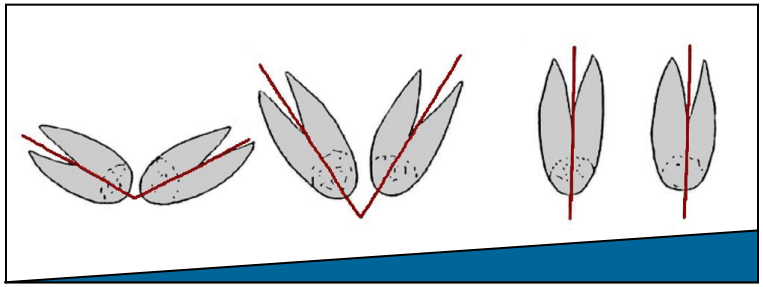

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Morphological synthetic grade

	2	3	4	9
ALPINE	37%	47%	12%	4%
SAANEN	32%	49%	15%	4%

Table 1 Average and standard deviation of type appraisal traits in Alpine and Saanen samples. (Manfredi et al., 2006)

Trait[a]	Alpine	Saanen
Number of goats	11 494	7821
Body, feet and legs		
Thorax perimeter (cm)	85.2±4.4	88.2±5.2
Back	4.93±0.50	4.84±0.52
Rump angle	4.28±0.81	4.49±0.79
Hock distance	6.23±1.09	6.61±1.09
Feet angle	6.15±1.13	6.43±1.16
Pastern	4.86±0.65	4.88±0.68
Udder and teats		
Fore udder	3.50±1.07	3.86±1.29
Udder profile	5.89±1.48	6.31±1.40
Udder floor position	6.62±0.96	6.50±1.07
Teat length (cm)	5.42±1.42	5.82±1.56
Teat width (cm)	2.89±0.88	2.95±0.92
Teat form	5.10±1.29	5.05±1.30
Teat angle	5.12±0.87	5.26±0.82
Teat placement	3.86±1.01	4.37±0.90
Teat orientation	3.81±0.88	4.24±0.83
Rear udder	5.37±1.10	5.24±1.14
Rear udder attachment	5.32±1.38	5.81±1.48

[a] Scores range from 1 to 9; units for measurements as indicated.

Table 2 Heritabilities and genetic correlations among body, feet and leg traits in the Alpine (upper diagonal) and Saanen (lower diagonal) breeds [a] . (Manfredi et al., 2006)

	TP	BA	RA	HD	FA	PA
TP: Thorax perimeter	0.50 0.41	0.07	0.20	0.23	0.18	−0.07
BA: Back	−0.28	0.08 0.03	0.19	0.08	0.07	0.32
RA: Rump angle	0.02	0.47	0.10 0.13	0.41	0.26	0.15
HD: Hock distance	0.17	−0.17	0.19	0.16 0.12	0.96	0.14
FA: Feet angle	0.26	−0.26	0.14	0.91	0.14 0.12	0.28
PA: Pastern	−0.34	0.12	−0.03	0.50	0.07	0.07 0.05

[a] Standard deviations of heritabilities between 0.02 and 0.04 (Alpine and Saanen). Standard deviations of genetic correlations between 0.08 and 0.14 (Alpine) and between 0.11 and 0.25 (Saanen).

Table 4
Heritabilities and genetic correlations among udder and teat traits in the Alpine (upper diagonal) and Saanen (lower diagonal) breeds [a] (Manfredi et al., 2006)

	UFR	UPR	UFL	TLE	TDI	TFO	TIN	TPL	TOR	URE	URA
UFR: fore udder	0.26	0.03	0.51	−0.28	−0.35	0.39	0.50	0.03	0.11	0.18	0.62
UPR: udder profile	0.33	0.36	0.02	0.70	0.68	−0.58	0.36	0.80	0.63	−0.59	0.08
UFL: udder floor	−0.09	0.27	0.34	−0.35	−0.40	0.29	0.08	0.15	0.17	0.08	0.77
TLE: teat length	0.58	0.06	0.33	0.52	0.92	−0.65	0.08	0.52	0.40	−0.45	−0.26
TDI: teat width	−0.41	0.67	−0.30	0.48	0.47	−0.90	0.06	0.49	0.34	−0.50	−0.31
TFO: teat form	−0.40	0.69	−0.31	0.88	0.43	0.37	−0.02	0.40	−0.23	0.49	0.27
TIN: teat angle	0.38	−0.61	0.30	−0.67	−0.94	0.36	0.18	0.35	0.23	−0.26	0.26
TPL: teat placement	0.23	0.37	0.16	−0.08	−0.08	0.08	0.15	0.35	0.93	−0.67	0.29
TOR: teat orientation	0.05	0.66	−0.01	0.41	0.35	−0.19	0.36	0.25	0.33	−0.52	0.37
URE: rear udder	0.17	0.61	0.12	0.33	0.20	−0.02	0.37	0.95	0.25	0.30	−0.04
URA: rear udder attachment	0.26	−0.35	0.32	−0.27	−0.26	0.26	−0.36	−0.59	−0.50	0.25	0.26
	0.65	0.16	0.72	−0.18	−0.12	0.15	0.21	0.20	0.25	0.39	0.28

[a] Standard deviations of heritabilities between 0.02 and 0.04 (Alpine) and between 0.03 and 0.04 (Saanen). Standard deviations of genetic correlations between 0.05 and 0.13 (Alpine) and between 0.05 and 0.11 (Saanen).

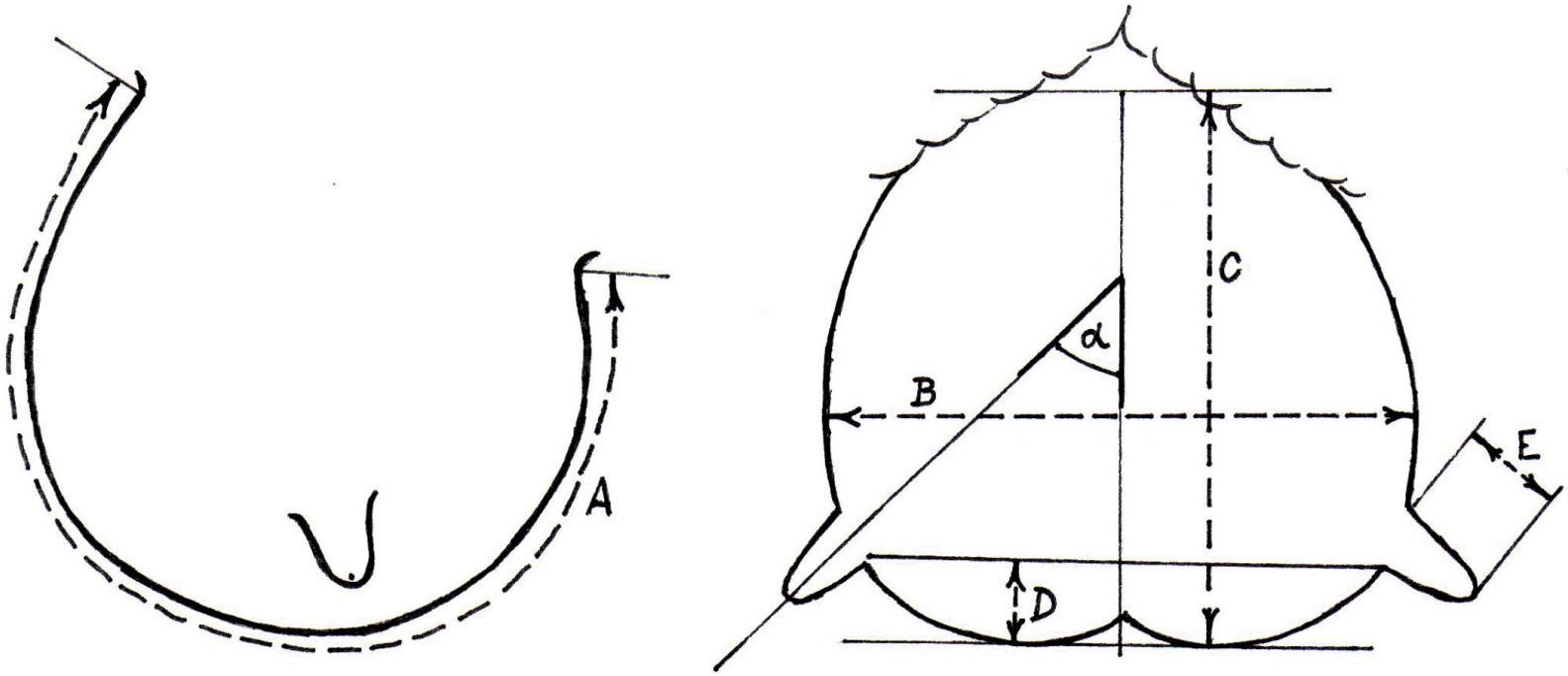

Figure 1. Udder measurements. A – udder length (UL), B – udder width (UW), C – rear udder depth (RUD), D – cistern depth (CD), E – teat length (TL), α – teat angle from the vertical (TA) (Milerski et al., 2006)

Table 1. Sample statistics of udder morphology measurements and linear scores in Tsigai, Improved Walachian and Lacaune dairy sheep breeds (Milerski et al., 2006)

Breed	Tsigai		Improved Walachian		Lacaune	
Number of sets of measurements	387		196		189	
Number of animals	123		83		60	
	mean	s.d.	mean	s.d.	Mean	s.d.
Linear udder assessment scores						
Udder depth	4.2	1.28	4.5	1.42	6.0	1.42
Cistern depth	3.8	1.73	4.1	1.84	6.0	1.73
Teat position	4.3	1.42	4.6	1.56	5.8	1.65
Teat size	4.5	1.33	4.8	1.12	4.4	1.29
Udder cleft	5.2	1.27	5.0	1.61	4.4	1.67
Udder attachment	5.0	1.14	5.3	1.24	5.4	1.42
Udder shape	4.6	1.48	4.9	1.46	5.8	1.48
Udder measurements						
Udder length (mm)	196.1	35.9	208.8	44.3	313.1	63.7
Udder width (mm)	106.7	13.8	112.1	17.9	132.2	18.2
Rear udder depth (mm)	133.7	22.6	136.1	26.7	184.2	34.5
Cistern depth (mm)	12.6	10.4	18.3	12.8	31.3	15.0
Teat length (mm)	35.3	6.7	36.5	6.0	33.6	5.1
Teat angle (°)	37.5	10.2	40.8	11.6	46.9	14.5
Cistern area from bottom (mm^2)	2 625	921	2 851	1 224	5 814	1 869
Cistern area from side (mm^2)	3 283	1 041	3 597	1 285	6 029	1 927

Table 3. Correlation coefficients between subjectively assessed linear scores of udder traits in Tsigai dairy ewes (Milerski et al., 2006)

	Cistern depth	Teat position	Teat size	Udder cleft	Udder attachment	Udder hape
Udder depth	n.s.	n.s.	n.s.	n.s.	0.667	0.842
Cistern depth		0.844	-0.171	-0.279	n.s.	n.s.
Teat position			-0.236	-0.336	n.s.	-0.220
Teat size				n.s.	n.s.	n.s.
Udder cleft					0.294	0.277
Udder attachment						0.791

Table 5. Correlation coefficients between subjectively assessed linear scores of udder traits in Improved Walachian dairy ewes (Milerski et al., 2006)

	Cistern depth	Teat position	Teat size	Udder cleft	Udder attachment	Udder shape
Udder depth	0.427	0.250	–0.257	0.221	0.542	0.794
Cistern depth		0.766	–0.245	n.s.	n.s.	n.s.
Teat position			–0.384	n.s.	n.s.	n.s.
Teat size				n.s.	n.s.	n.s.
Udder cleft					0.294	0.319
Udder attachment						0.796

Table 7. Correlation coefficients between subjectively assessed linear scores of udder traits in Lacaune dairy ewes (Milerski et al., 2006)

	Cistern depth	Teat position	Teat size	Udder cleft	Udder attachment	Udder shape
Udder depth	0.296	n.s.	0.277	n.s.	n.s.	n.s.
Cistern depth		0.903	n.s.	–0.285	–0.371	–0.300
Teat position			n.s.	n.s.	–0.426	–0.372
Teat size				n.s.	n.s.	n.s.
Udder cleft					n.s.	n.s.
Udder attachment						0.776

TABLE I. Characteristics of mammary morphology in Churra ewes (Fernandez et al., 1995)

Character	Whole udder			Left udder		Right udder		
	$\bar{X}$	SE	CV	$\bar{X}$	SE	$\bar{X}$	SE	r[1]
Udder depth, cm	9.30	.13	30.42					
Udder width, cm	12.18	.12	21.54					
Udder circumference, cm	46.55	.37	16.91					
Cistern height, cm	1.48	.05	70.98	1.45	.05	1.50	.05	.78
Teat position[2]	3.64	.04	25.06	3.64	.03	3.65	.04	.93
Teat angle, °	50.39	.63	26.45	50.17	.67	50.61	.65	.82
Teat length, cm	3.83	.04	20.82	3.83	.04	3.83	.04	.81
Teat width, cm	1.93	.02	22.14	1.93	.02	1.93	.02	.72

[1]Correlation coefficient between left and right udder halves.

[2]Teat position (lateral view) scored from 1 = turned backwards to 5 = much forward.

TABLE 2. Correlations between udder traits. [1] (Fernandez et al., 1995)

	Udder depth	Udder width	Udder circumference	Cistern height	Position of teat	Teat angle	Teat length	Teat width
Udder depth		.80***	.87***	−.01	−.26	−.17***	.22***	.21***
Udder width	.57***		.90***	−.08	−.31***	−.24***	.19***	.20***
Udder circumference	.74***	.76***		−.08	−.30***	−.23***	.22***	.19***
Cistern height	.35***	−.20***	−.17***		.55***	.57***	−.31***	−.25***
Teat position	.07	−.22***	−.18***	.55***		.59***	−.31***	−.19***
Teat angle	.04	−.17***	−.13***	.56***	.53***		−.48***	−.36***
Teat length	.28***	.26***	.28***	−.29***	−.26***	−.45***		.64***
Teat width	.16***	.19***	.16***	−.23***	−.09*	−.30***	.63***	

[1]Phenotypic correlation coefficients are above diagonal, and residual correlation coefficients from the ANOVA are below the diagonal.

*$P < .05$.

***$P < .001$.

TABLE 5. Least squares means (LSM) and standard errors of dependent variables by lactation month. (Fernandez et al., 1995)

	Month							
	1		2		3		4	
Dependent variable	LSM	SE	LSM	SE	LSM	SE	LSM	SE
Udder depth, cm	11.48[a]	.19	9.90[b]	.19	8.31[c]	.19	7.29[d]	.19
Udder width, cm	13.75[a]	.17	12.68[b]	.17	11.40[c]	.17	10.15[d]	.17
Udder circumference, cm	51.53[a]	.53	48.68[b]	.53	44.52[c]	.53	40.92[d]	.53
Cistern height, cm	1.43[a]	.09	1.28[ab]	.09	1.31[ab]	.09	1.18[b]	.09
Teat position[1]	3.28[b]	.08	3.30[b]	.08	3.68[a]	.08	3.86[a]	.08
Teat angle, °	47.61[b]	1.27	45.21[b]	1.27	49.95[ab]	1.27	51.47[a]	1.27
Teat length, cm	3.97[b]	.07	4.21[a]	.07	3.81[b]	.07	3.78[b]	.07
Teat width, cm	2.04[a]	.04	2.04[a]	.04	1.96[ab]	.04	1.88[b]	.04

[a,b,c,d]Means in a row with different superscripts differ ($P < .05$).

[1]Teat position (lateral view) scored from 1 = turned backwards to 5 = much forward.

TABLE 7. Least squares means (LSM) and standard error of dependent variables by panty numbers. (Fernandez et al., 1995)

	Parity					
	1		2		≥3	
Dependent variable	LSM	SE	LSM	SE	LSM	SE
Udder depth, cm	9.35[a]	.26	9.37[a]	.17	9.01[a]	.12
Udder width, cm	11.58[b]	.11	12.06[a]	.15	12.08[a]	.10
Udder circumference, cm	46.78[a]	.71	46.61[a]	.49	45.86[a]	.33
Cistern height, cm	.86[c]	.13	1.21[b]	.09	1.84[a]	.06
Teat position[1]	3.29[b]	.11	3.44[b]	.07	3.86[a]	.05
Teat angle, °	46.56[b]	1.71	45.40[b]	1.17	53.73[a]	.80
Teat length, cm	4.14[a]	.10	3.90[ab]	.04	3.74[b]	.04
Teat width, cm	2.10[a]	.05	1.95[b]	.03	1.88[b]	.02

[a,b,c]Means in a row with different superscripts differ ($P < .05$).

[1]Teat position (lateral view) scored from 1 = turned backwards to 5 = much forward.

TABLE 8. Least squares means (LSM) and standard errors of dependent variables by milk yield. (Fernandez et al., 1995)

	Milk yield[1]					
	1		2		3	
Dependent variable	LSM	SE	LSM	SE	LSM	SE
Udder depth, cm	8.11[c]	.18	9.47[b]	.14	10.14[a]	.21
Udder width, cm	10.59[c]	.15	12.67[b]	.12	13.14[a]	.18
Udder circumference, cm	41.97[c]	.49	47.28[b]	.40	49.99[a]	.58
Cistern height, cm	1.36[a]	.09	1.07[b]	.07	1.48[a]	.10
Teat position[1]	3.58[a]	.07	3.47[a]	.06	3.54[a]	.09
Teat angle, °	51.09[a]	1.17	48.20[b]	.95	46.40[b]	1.38
Teat length, cm	3.82[b]	.07	3.94[ab]	.05	4.02[a]	.08
Teat width, cm	1.96[ab]	.03	1.94[b]	.03	2.04[a]	.04

[a,b,c]Means in a row with different superscripts differ ($P < .05$).

[1]Yield 1: <100 L, 2: 100 to 150, and 3: >150 L.

[2]Teat position (lateral view) scored from 1 = turned backwards to 5 = much forward.

Conclusions

- Dairy goat selection has been oriented towards improvement of milk yield and solid contents, but the udder was often due to baggy, the size of both sides udder was inconsistent, and the size of teat and position was unfavorable for milking trouble caused. The glandular cistern is an internal structure of the udder and is neither visible nor measurable externally, but can be measured by ultrasonography. However, the complexity and high cost of this technique do not allow its use for large populations in a breeding program. Morphological appraisal type have been used for phenotypic culling of dams of young bucks candidates for progeny testing in France. Udder morphology traits were measured by the use of linear score system in improving the machine milking ability, avoid milking time is too long, increase working hours, it included fore udder, udder profile, udder floor position, teat length teat width, teat form, teat angle, teat placement, teat orientation, rear udder and rear udder attachment to is scored from 1 to 9. Heritabilities for udder and teat scores were about 0.3, teat angle having the lowest values (less than 0.2). Teat measurements (width and length) had heritabilities over 0.4. Genetic correlations among teat dimension were high (correlation over 0.85 between teat length and width). Genetic correlations among teat location traits were also high (correlation over 0.9 between teat placement and teat orientation). Genetic correlations among udder and teat traits are important and vary according to breeds. In the dairy goat genetic correlations between EBVs for the type and for milk yield suggest low associations, but must be found to simultaneously improve milk yield and traits related to the suspensory system of the udder.

Thanks for your attention