

Mammalian post-natal test of vitality presented on a *Bos taurus* model*

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The behaviour of ten beef and six dairy cow-calf pairs was recorded between birth and first ingestion of colostrum. Effects were length, diameter, conicity and distance to the floor of each teat, girth of udder and height of wither of each calf, breed, lactation number, type of teat grasping and sex. Three teat grasping tactics could be defined: biter, tongue player and sucker. Effects were grouped representing cow, calf, udder and teat. Three sub-periods were defined. (i) From end of calving until the first touch of the standing calf's head with a teat, influenced by lactation number. (ii) From the first touch of the standing calf's head with a teat until the first teat was placed longitudinally in the calf's mouth, influenced by teat grasping tactic. (iii) From the first teat being placed longitudinally in the calf's mouth until the first ingestion of a substantial amount of colostrum influenced by teat conicity. A vitality evaluation hypothesis is presented to explain the functional implications of a surplus of milk and the clumsiness of some individual offspring to ingest it.

KEY WORDS: suckling/ first meals / fitness/ mother/ offspring

The placenta of some mammalian species (e.g., *Homo sapiens*) allows the passage of large molecules between mother and offspring during pregnancy. In other species

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(e.g., *Bos taurus*) such *pre-natal* transfer of e.g., immunoglobulins is not feasible. Therefore, those species need the oral transfer of antibodies from the mother shortly *post partum* (*pp*). Others (e.g., *Sus scrofa*) need additionally fast energy supply to accelerate the build up of their thermoregulation, which is insufficient at birth.

This paper presents a general hypothesis within the context of the need of early ingestion described above, on a data set of one model species (*Bos taurus*). When emphasising the general aspects of immediate *pp* ingestion, the terms “milk”, “mother”, and “offspring”, when dealing exclusively with our model species *Bos taurus*, “colostrum”, “dam”, and “calf” are used in the following.

An early supply with a substantial amount of colostrum [Ventorp and Michanek 1992] is of vital importance for the survival, well being [Villouta *et al.* 1980, Braun and Tennant 1983] and even probably later fitness [Le Neindre 1989] of the calf. Early ingestion of a substantial amount of colostrum is necessary for the following reasons:

- The content of immunoglobulins in the colostrum is decreasing over time [Kruse 1970, Fallon 1979];
- the period during which the passageway of large, intact molecules through the wall of the offspring’s intestine is limited [Stott *et al.* 1979];
- the ingestion of colostrum accelerates the loss of the ability to assimilate large intact molecules [Stott *et al.* 1979, Michanek *et al.* 1989].

Langholz *et al.* [1987] showed that the concentration of immunoglobulins in colostrum varied substantially between lactation numbers of the dam. A calf from a primiparous dam could get too little immunoglobulins if it suckled from one teat only. However, a general shortage of the amount of milk *pp* is not in accordance with the experience of farmers and zoo guardians. On the opposite, at birth there used to be a surplus of milk available in the mammary gland in at least a large number of mammalian species, e.g., *Bos taurus* [Henkel and Mühlbach 1906], *Sus scrofa* [Castrén 1993], *Giraffa camelopardalis*, *Taurotragus oryx derbianus*, *Tursiops truncatus* [Amundin and Röken, personal information].

Numerous references reported that there was a harmful delay before the first ingestion of colostrums [Derenbach 1981]. Possible reasons for that delay have been the subject of much study and numerous factors for it were analysed:

- behaviour of the dam [Selman *et al.* 1970a, Edwards and Broom 1982, Ventorp and Michanek 1991, Ventorp and Michanek 1992];
- behaviour of the calf [Selman *et al.* 1970b, Edwards 1982, Edwards and Broom 1982, Langholz *et al.* 1987, Ventorp and Michanek 1991];
- calving season mostly confounded with indoor period [Edwards 1982, Edwards and Broom 1982, Edwards *et al.* 1982, Langholz *et al.* 1987];
- age of dam also often confounded with calving season [Edwards 1982, Edwards *et al.* 1982, Devery-Pocius and Larson 1983, Langholz *et al.* 1987, Ventorp and Michanek 1992];

- anatomical udder conformation, referred to as “anatomy hypothesis” in the following [Edwards 1982, Edwards and Broom 1982, Ventorp and Michanek 1991, Ventorp and Michanek 1992];
- breed [Selman et al. 1970b, Edwards 1982, Langholz *et al.* 1987, Le Neindre 1989].

The sex of the calf [Lidfors and Jensen 1988], the difficulty of parturition [Edwards 1982], the weight of the newborn [Langholz *et al.* 1987] and the own rearing conditions of the dam [Le Neindre 1989] were reported once to influence the ingestion of colostrum.

Thus, the availability of considerable amounts of colostrum is not a guarantee for early and sufficient ingestion *per se*. Observing the first attempts to ingest colostrum by a newborn calf, an observer cannot but be puzzled by the clumsiness of some individuals. Several attempts were made to analyse this immediate *pp* behaviour of the calf by introducing sub-periods or activities between birth and first ingestion of colostrum. Derenbach [1981] differed between two periods: from rising into standing position until the first occurrence of teat seeking movements and from the first occurrence of teat seeking movements to the first successful sucking and swallowing movements. Ventorp and Michanek [1991] presented overlapping activities respectively periods: first attempt to rise, standing, teat seeking, finding udder, and finding teat before suckling.

Most studies mentioned regarded an insufficient supply of the new-born calf with colostrum as a defect deriving from domestication. Domestication was said resulting in e.g., pendulous udders, too low teat, *etc* – a type of enlarged anatomy hypothesis. This interpretation remained mostly unspoken but was also given *expressis verbis* by Michanek [1994]. To support the domestication effect Michanek [1994] quoted reports about early suckling of wild species. The authors of this report doubt whether those observations can be taken as a general rule for the following reasons:

- observations from distance might often miss essential details;
- calves stillborn during night might be overlooked during daylight observations;
- later but still close to *pp* losses might be not recorded.

Our view is that the behavioural clumsiness of the calf, and partially also of the dam in front of an available abundance of colostrum is an observable part of a fundamental evolutionary process. This process is valid principally for all mammalian species, domesticated or not. Domestication may strengthen or alter that process, however, it still acts within its framework.

Our question was what the functional implication might be of a surplus of milk combined with the clumsiness of some individual offspring and dams. To answer that question we propose the following hypothesis:

- (1) Production costs of a mammalian mother for a foetus are negligible compared to the milk production costs during lactation [Migula 1969, Myrcha *et al.* 1969, Studier 1979, Fedak and Anderson 1982].
- (2) A surplus of milk at birth guarantees the survival of a vital offspring.
- (3) The offspring has to prove its vitality by overcoming difficulties before being able to ingest milk.
- (4) The best period for an evaluation of offspring vitality is before the mother's heavy investment in lactation, *i.e.* during the immediate *post-natal* period.

We nominate the four sentences above “vitality evaluation hypothesis” (referred to as VEH in the following).

The main objective of the research reported here was to present VEH by analysing the variance of the period from birth to first ingestion of colostrum on a model data set. This main objective was partially hampered, partially favoured by the data set available. Originally the data set was recorded for a different purpose [Mayntz 1996]. Therefore it was small for the study presented here and eventual confounding had to be analysed and controlled as far as possible. Thus the detailed objectives were:

- (1) to find clearly defined sub-periods between birth and first ingestion of colostrum that were related *via* behaviour of dam and calf to VEH;
- (2) to find potential new effects for analysis of variance of the sub-period mentioned in item (1) under the aspect of VEH;
- (3) to select models for the analysis of variance of those sub-periods including as many as appropriate of the new effect mentioned in item (2) and the older effects identified earlier.

A secondary objective was to record and to analyse the swallowing rate because the use of the terms “sucking” [Lidfors and Isberg 2003], “suckling” (the overwhelming majority of references) and even “swallowing” [Derenbach 1981] seemed to be sometimes arbitrary in related references.

Material and methods

Animals

Ten beef cow-calf-pairs (nine Hereford and one Charolais) were randomly selected from the herd of the Research Station of Ecological Agriculture and Breeding of Endangered Animals in Popielno, Poland. The management applied in that herd resulted in concentrated spring calving. A recording period from March 28 to April 8 was agreed before the onset of recording. Cow-calf-pairs, the calves of which were born during this period and observation hours (see further down), should be recorded. The lactation number of the dams thereby selected varied between one and five.

Additional six dairy cow-calf-pair's (Polish Holstein-Friesian) were selected from another herd at the same Research Station in a corresponding manner two years later. The dairy herd averaged about 5500 litres per year on a grass-dominated diet during the year before the observations.

Table 1 follows the sequence of birth within breed and summarises the characteristics of the animals. During the short birth periods chosen, no change of food or weather occurred in either herd.

Management

The calving stable of the beef cows was equipped with single cubicles (5.5 m²). There was a 5 to 10 cm thick straw mattress in the cubicles. Cows were loosely tethered within the cubicles with a *ca* 1.3 m long chains during birth and early lactation. Solid 1.25 m high wooden walls separated adjacent cubicles. The animals were fed silage and hay *ad libitum* twice a day and a minor portion of concentrate once a day.

The dairy cows were kept in a conventional tied-up stall. The selected cow-calf-pairs were taken to a separate nearby pasture immediately before or after (one cow-calf pair) calving. The six cow-calf pairs stayed together on pasture during the following recording period. The cows were not milked during observation.

Thus breed was confounded with management. Therefore the special “breed-management-interaction” analysed here is meant in the following when speaking about the effect “breed”.

Recording of behaviour

Visual control and video recording was carried out from 05.00 to 20.00 every day during the observation period. When a birth happened during these hours video recording of that cow-calf-pair continued until the end of the first suckling meal. The end of the first meal was defined as the last teat contact that was preceded by ingestion of colostrum and followed by lying down of the calf. The camera was placed near the floor during recording to get an uncovered view on the udder and the actions of the calf. A time code was copied on the videotapes, allowing different activities to be separated with an accuracy of 0.04 seconds.

Recording of swallowing rate

With five beef and three dairy-cow-calf-pairs an observer touched the oesophagus of the suckling calf during a meal on day 3 or 4 *pp* to feel swallowing movements. Counting loudly the movements of the oesophagus should record the frequency of those movements on the videotape.

Anatomical measurements

On the second day of life, the following measurements were recorded: length, diameter in the middle and conicity angle of each teat, distances of teat tips to the floor (referred to as teat-ground-distance in the following), girth of udder, measured at teats' base and height of the wither of the calf. Conicity was defined as the angle between an ideal midline and the tangent line along the teat wall. To record conicity, a transparent plate with the middle line and lines at angles of 3, 6, 9, 12 and 15° relative to the middle line was held in front of the teat.

Some of these measurements were summarised into the following additional potential effects: average teat length, average teat diameter, average teat conicity.

Establishment of new sub-periods and new effects

Three to five observers viewed the tapes in random order and at different speeds. Criteria for the establishment of new sub-periods between birth and ingestion of colostrum were clear and unambiguous borders between those new periods that were not submitted to subjective judgement but related to behaviour. Further, the end of preceding sub-period should coincide with the start of the following one. Similar criteria concerning clarity and relation to behaviour were used for the definition of new effects.

Data-evaluation – analysis of eventual confounding and principles

In addition to the anatomical measurements, other effects mentioned above were taken into account: breed, lactation number, sex and height of the wither of the calf. Height of wither represented the vigour of the newborn to some extent.

Linear regression and student's t-test were used to test whether lactation number, breed, and sex were confounded with anatomical measurements. Four ways of grouping lactation numbers were applied (i: =1, =2, =3, =4, =5; ii: ≤ 2 , =3, =4, =5, iii: ≤ 2 , =3, ≥ 4 ; iv: ≤ 3 , ≥ 4) to test lactation-breed-interaction between and within the breeds. Further, both lactation number and breed always should be included together in a model.

Confounding and nuisance for the analysis reported here could not be taken care of at recording due to the original different objective of the study [Mayntz 1996]. Additionally, the available data set had a small size for the analysis reported here. Therefore modelling had to follow the principals and biological arguments mentioned below.

- The number of effects had to be minimised without hazarding the objective. Therefore we grouped our final effects into four groups: those representing characteristics of the cow (breed, lactation number), the calf (height of wither, type of teat grasping, sex), the udder (udder girth, minimum teat ground distance) and the teat (average teat length, diameter, conicity);
- modelling started with all groups involved and went on by gradually eliminating complete groups.

Data-evaluation – statistics for the analysis of new sub-periods

Before analysis, new sub-periods, *i.e.*, variables had to be established as described further down. The different models mentioned above and GLM were used for the analysis of variance of these sub-periods. Least squares means between levels of significant fixed effects were compared with Student's t-test.

Results and discussion

Calving sequence and lactation number of dam were not systematically confounded in our data set (Tab. 1). Only teat-ground-distance was influenced by groups of lactation number; the beef cows of the fifth lactation turned the regression into a second degree polynomial. The rougher grouping of lactation numbers, the less

Table 1. Main characteristics of animals; TGD: teat-ground-distance

Breed	Sex	Lactation No.	Type of teat grasping	Average teat length	Minimum TGD	Average teat diameter	Average teat conicity	Udder girth	Height of wither
Hereford	male	4	sucker	71	42.00	29.25	6.56	65	75
Hereford	male	2	tongue player	74	46.00	28.75	5.59	77	67
Hereford	female	5	sucker	62.75	46.50	26.50	5.25	70	70
Hereford	female	5	biter	53.50	49.00	26.00	2.19	77	63
Hereford	male	4	tongue player	52.25	45.00	27.00	3.50	66	78
Hereford	male	1	biter	57	56.00	25.75	1.50	62	65
Hereford	female	2	sucker	37.5	57.00	37.00	7.88	65	80
Hereford	female	3	tongue player	55.00	45.00	29.50	4.38	68	76
Hereford	male	3	biter	57.75	40.00	28.00	5.59	78	69
Charolais	male	3	tongue player	58.00	47.50	28.75	4.62	70	71
Friesian	male	4	biter	61.3	35.00	37.00	7.88	94	72
Friesian	female	3	tongue player	73.75	39.00	31.00	4.38	90	69
Friesian	female	4	biter	63.75	36.00	25.75	2.63	80	72
Friesian	male	3	sucker	55.00	37.00	27.25	3.50	68	72
Friesian	female	3	biter	41.25	43.00	22.50	1.75	75	71
Friesian	male	4	tongue player	57.75	33.00	33.00	5.25	88	69

Table 2. Effect of breed on anatomical measurements. Figures with different superscripts differ on the 0.05% level. TGD: teat-ground distance.

Variable	Mean beef breed, all lactations	Mean of beef breed, 3 and 4 lactation	Mean of dairy breed
Average teat length (mm)	57.9	58.8	58.8
Average teat diameter (mm)	28.7	28.5	29.42
Average teat conicity (grad)	4.72	4.93	4.23
Minimum TGD (cm)	47.4 ^a	43.9 ^a	37.17 ^b
Udder girth (cm)	69.8 ^a	69.4 ^a	82.5 ^b
Height of wither (cm)	71.4	73.8	70.83

detailed the relationship between dependent and independent variables. No effect on any variable was seen in the roughest lactation grouping ($d: \leq 3, \geq 4$). There was no influence of the two lactation numbers of the dairy cows on any of the anatomical measurements.

Dairy cows had lower minimum teat-ground-distance and larger udder girth than beef cows (Tab. 2). These differences are also significant when only beef cows with lactation numbers equal to those of the dairy cows are included. Sex of the calf had no influence on any anatomical measurement.

The sample of cow-calf-pairs used here was small and not free of interaction/confounding. Therefore discussion is concentrated mainly on VEH.

New effects

Viewing the tapes several times in random order and at different speeds resulted in that three teat grasping tactics could be distinguished. Also concerning these tactics, all viewers of the tapes expressed similar observations and classifications of the calves independently. The three teat grasping tactics were:

- According to the teat grasping tactic described in detail by Derenbach [1981], a calf that once happen to touch a teat with the muzzle tried to grasp the teat base between the jaws. If the teat did not slip away at that moment, it was placed in the mouth athwart. Short teats often slipped already now into the mouth and sucking movements started. Longer and/or stiffer and/or more conical teats, however, did not bend and repeatedly slipped out of the mouth again. In that case the calf bit its way down to the teat tip. Once the teat tip had been placed in the mouth, the rest of the teat followed into the mouth. Now the whole teat or major parts of it were placed longitudinally in the mouth. We called a calf, applying that tactic, a “biter”.
- Other animals behaved in principal like a biter. However, they opened the mouth wider and used the tongue to grasp the object also in some distance from the mouth. The use of the tongue became more intensive when they had touched a teat or teat-like object with the nose. We called a calf, applying that tactic, a “tongue player”.
- A third group of calves neither bit nor tongue played. They kept jaws firmly closed and pressed the muzzle strongly on the surface of the dam’s body. Simultaneously they suck strongly. Thus loose body parts like e.g., skin wrinkles were sucked into the mouth. If such a calf happened to come across the udder, a teat could slip into the mouth eventually. We called a calf, applying that tactic, a “sucker”.

We do not assume that the teat grasping tactics described here indicate genetic differences between individual calves. Rather we interpret that the ethnogram of a newborn calf being much more unspecified than anthropomorphically biased observers usually imagine. This view is supported by the initial attraction of calves towards any “prehension facilitating protuberance”[Cross 1977].

In our data set we found six tongue players, six biters and four suckers (Tab. 1). It was striking to observe with which stubbornness an individual offspring stuck to its initial teat grasping tactic. E.g. a sucker never became a biter or tongue player until and during the first meal, *i.e.* unless its initial attempts had been successful. A change in tactics would have decreased the time until the vital ingestion of colostrum especially for suckers, but they insisted. After all calves had learned to find, grasp and suckle a teat, they all turned into tongue players. First-born *Bos taurus* calves, applying a sucker-tactic would probably be the majority among those not passing the vitality evaluation in the wild. In that context we want to stress that we present a *post-natal* vitality test. The actual outcome of that test, *i.e.* the eventual death of a non vital offspring might be seen later.

New sub-periods

Three clearly distinguishable and measurable new sub-periods were found by repeated viewing of the video recordings at different speeds.

- From end of calving, *i.e.* from the moment when the calf 's body including legs was delivered completely until the first touch of the standing calf's head with a teat (P1).
- From the first touch of the standing calf's head with a teat until the first teat was placed longitudinally in the calf's mouth (P2).
- From the first teat being placed longitudinally in the calf's mouth until the first ingestion of a substantial amount of colostrum (P3).

The following conditions had to be fulfilled to claim an ingestion of a substantial amount of colostrum: the suckled teat should be stretched and not bent sharply at the teat base and the calf should exert sucking movements with its lower jaw for at least 1 minute uninterruptedly. The two first conditions are not automatically occurring simultaneously.

Table 3 summarises the finally chosen models for the new sub-periods mentioned above. The formerly defined sub-periods were either overlapping [Michanek 1994] and therefore unfit for our type of analysis or not precise enough. "Teat seeking movements", described by Derenbach [1981] as "vertical head movements" occurred very arbitrarily. Five of our calves showed such movements already when still lying after calving.

Biological arguments were intended to lead the search for optimal models. Therefore we decided for the stepwise elimination of complete biologically founded effect-groups. Apparently we managed to describe true biological subjects with the new sub-periods because each was influenced by one main effect: P1 by lactation number, P2 by teat grasping tactic and P3 by teat conicity. The F-values of these main effects were comparatively constant between the different tested models. P1 lasted on average 5242, P2 1542 and P3 – 7 seconds or about 77%, 22.9%, 0.1%, respectively of the total period from end of birth to the start of first ingestion of a sufficient amount of colostrum. The total period lasted on average for almost 2 hours.

Table 3. Results of finally chosen models for analysis of variance of the periods from end of calving to first touch of the standing calf's head with a teat (P1), from first touch of the standing calf's head with a teat to first teat in the mouth (P2) and from first teat in the mouth to first ingestion of colostrums (P3), c: class variable, *r*: regression, lactation group ii: ≤2, =3, =4, =5

Period number	Effect group	Effects and their character	R ² (model) resp. Prob. >F
P1	cow	breed, c	0.68; 0.008
		lactation group b, c	0.63
			0.0096
P2	calf	height of wither, <i>r</i>	0.8; 0.0007
		type of teat grasping, c	0.65
		sex, c	0.0006
P3	teat	sex, c	0.65
		average teat length, <i>r</i>	0.75; 0.0007
		average teat diameter, <i>r</i>	0.13
		average teat conicity, <i>r</i>	0.02
		average teat conicity, <i>r</i>	0.0003

The range was between 1 and 3.3 hours, which was slightly longer than the figures given by Derenbach [1981]. That could be explained by her starting event “rising into standing position”, occurred later than “from end of calving”, used in the evaluation reported here.

The border between P1 and P2, *i.e.* the first touch of the standing calf's head with a teat, seemed to be a key moment in the whole process. Once a calf had touched a teat with it's head, the actions of the calf became more distinct and oriented. This impression was especially strong, when that touch occurred with the upper ridge of the nose and not so much with the muzzle. This subjective impression should not be stressed too much. However, all persons, who viewed the tapes, expressed similar impressions independently.

P1 was influenced to an overwhelming extent by the lactation number of the dam. Figure 1 demonstrates the effect of lactation group. Lactation number probably represented mostly experience. Ongoing physiological maturing processes [Edwards 1982, Edwards *et al.* 1982, Devery-Pocius and Larson 1983, Langholz *et al.* 1987, Ventorp and Michanek 1992] might have contributed to significantly longer P1 especially in the first lactation. Teat-ground-distance decreased with increasing lactation number except for the beef cows in the fifth lactation. Thus P1 should become longer with increasing lactation number according to the anatomy hypothesis. However, the results reported here were opposite. Even the fifth lactation dams with bigger teat-ground distance than the fourth lactation dams showed significant results

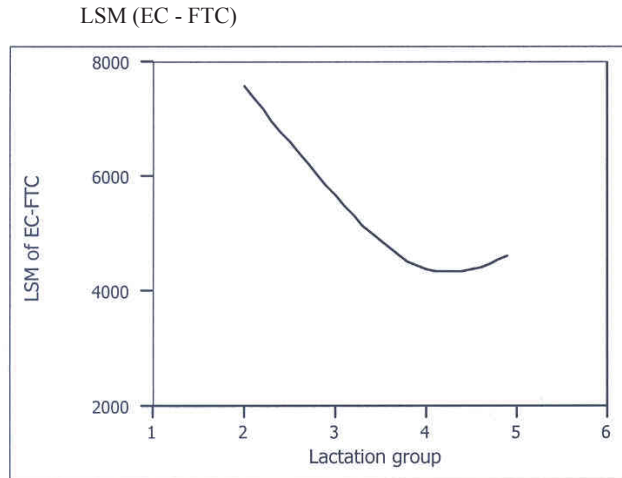


Fig. 1. Spline regression ($\alpha = 0.5$; $r^2 = 0.848$) between lactation group ii (lactation numbers: ≤ 2 , =3, =4, =5) and least square means (LSM) of the period from end of calving until the first touch of the standing calf's head with a teat (EC - FTC).

opposite to the anatomy hypothesis. Therefore we prefer to hypothesise that increasing experience of the dam shortened P1 until other age dependent factors counterbalanced experience. Those age-dependent factors might be e.g., deep hanging udders [Ventorp and Michanek 1992]. On the basis of our results we rather hypothesise a physiological exhaustion of the oldest cows.

Experience of the dam might have facilitated the calf's teat seeking in the following ways:

- the dam took a position relatively to the seeking calf that exposed her udder especially by appropriate hind leg position and thus favoured the offspring's teat seeking activities;
- the dam did not apply excessive care, e.g., strong anal licking during ongoing teat seeking efforts of the calf that was still very uncertain in standing position;
- the dam did not kick when the calf pushed the udder during teat seeking.

The unexplained variance in the analysis of P1 also might have included a real vitality character belonging exclusively to the calf. Unfortunately the farm routine did not allow weighing the newborn, which might have represented such calf vigour more directly than height of wither. With this reservation in mind, our data set did not support the hypothesis that the calf's vigour influenced P1.

The type of teat grasping was overwhelmingly responsible for the length of P2. The second calf from top of Table 1 demonstrated how essential that teat grasping tactic was for the success of the calf. Its mother kicked violently whenever the calf touched the udder region. Very fast the calf learned to avoid contacting the udder but managed to grasp a teat very gently with its tongue from distance. Once the teat was

suckled for a couple of seconds, the dam calmed down gradually. She accepted contact between the head of the calf and the first suckled quarter at the end of day one *pp*.

Teat diameter and conicity effected P3. The detection of P3 was the exclusive result of the careful observation, which was feasible by repeated, sometimes frame by frame viewing of video tapes. Sometimes the clumsiness of the newborn led to teats being sharply bent at the teat base. Thicker teats resisted better to that kind of bending, but a very conical teat shape could also result in that such closure of the udder-teat-passageway persisted. Such an animal (no. 7 from top in Table 1) was the only one, where the farm manager intervened. When the calf repeatedly tried to suck the most conical teat of that dam unsuccessfully, he handmilked a small amount from that quarter: "They always try the same teat and especially that teat must be softer. Otherwise she won't get any milk." A suckling calf has to close the udder-teat-passage way to prevent the milk in the teat cistern from flowing back to the quarter cistern [Becker 1955]. That makes the influence of teat conicity comprehensible.

Anatomical measurements e.g., low teats, wide udders [Ventorp and Michanek 1992] had no substantial effect on the period from end of calving to first ingestion of colostrums. Our data did not support the anatomy hypothesis despite that our lowest teats (Tab. 1) were even lower than those, which Ventorp and Michanek [1992] reported to prolong the period from calving to ingestion. However, the same authors claimed that low teats might be detrimental only in combination with other factors. Langholz *et al.* [1987] even described that too high teats of primiparous dams hampered newborn calves. If significant anatomical effects were found in our data set, e.g. in P3, their influence on the total period from end of calving to first ingestion of colostrums was very limited compared to the experience of the dam and the behavioural abilities of the calf.

Presentation of the vitality evaluation hypothesis (VEH)

The anatomy hypothesis seems to be very suggestive. But there is also a cultural bias in the minds of human observers, *i.e.* wild conditions are regarded as ideal, domesticated ones as degenerated *per se*. That bias became clear when Michanek [1994] compared *pp* behaviour of wild follower populations e.g., *Ovibos moschatus* [Jingfors 1984] or *Connochaetes taurinus* [Estes and Estes 1979] with that of *Bos taurus*, a domesticated hider species. VEH formulates an outspoken alternative to the underlying meaning of the enlarged anatomy hypothesis, however, rather by restricting its validity than by completely rejecting it.

The data set was sufficient to present VEH and to demonstrate that biologically important events can be found that help to analyse the *pp* behaviour under the aspect of VEH. These biologically important events probably differ between species groups. The principles of the VEH described here on a *Bos taurus* model might be valid for all species, who's parental investment after birth or hatching substantially exceeds the investment before that moment. Following the results presented here, we would describe the vitality evaluation in many mammal species as a period with abundant

maternal resources, during which mother and offspring in cooperation have to overcome difficulties to make use of these resources. Thus we would partially rephrase the third sentence in VEH given above: "Offspring and mother have to prove their vitality by overcoming difficulties before ingestion of milk."

A hard test of VEH itself could consist in controlling the following alternative hypotheses:

- (1) mammalian species show an early *pp* top of losses of offspring or of measure to prevent such losses;
- (2) most of such losses resulted from too late and/or too little ingestion of milk;
- (3) the majority of the cases identified in item (2) showed behavioural *pp* clumsiness.

An argument could be that VEH stresses the co-operation between mother and offspring. Indeed, VEH deliberately does not contribute to the question whether natural selection acts on the mother or the offspring [Birgerson and Ekvall 1997]. Male offspring of *e.g. Dama dama* emptied their mother's mammary gland faster (Birgerson, personal communication). Therefore they decreased the secretion-impeding fraction of protein [Wilde *et al.* 1988] in the alveoli during the short period of oxytocin action more than slower suckling female (half)-siblings and thus enhanced secretion during the ongoing lactation. This example encourages us to stress the co-operation between mother and offspring in the *post-natal* vitality test. Such co-operation does not exclude controversial interests between mother and offspring. However "how or why progeny gets to the next generations is less important than that they succeed in getting there" (Beilharz, personal communication).

Swallowing

Only suckling and sucking activities according to the definition of Hall *et al.* [1988] can be observed visually. Measuring milk ingestion during a suckling meal either demand high risk surgery at the oesophagus or a scale with a precision of millilitres and insensitivity against the movements of the suckling offspring. Derenbach [1981] interpreted suckling movements as swallowing, which suggests being closer to milk ingestion. Therefore we tried to count movements of the oesophagus. When the method described above was applied, dam and calf did not interrupt the suckling meal or changed visually observable behaviour. Some movements of the oesophagus should have been felt if the nomination "swallowing" would be justified. However, no movements of the oesophagus could be felt at any time. This failure might be explained in many ways. Gulps of milk might have been transported out of mouth cavity with the same frequency as sucking, however, there is no evidence that this must be so. Mayntz [1996] reported that As after-suckling lasted for at least 5 minutes. Lidfors *et al.* [1994] claimed that the after-suckling period of the calf at least partially is non-nutritive. Rasmussen and Mayntz [1998] reported that sucking movements of the lower jaw were carried out *in vivo* with 2 to 2.4 Hz. Thus a swallowing frequency similar to sucking frequency would have resulted in a minimum of 600 to

700 consecutive swallowing acts without substantial amounts of fluid. If, however, sucking and swallowing frequency differ, swallowing ought to be slower. This view is supported by the results of Wise *et al.* [1984], who found much lower irregular frequencies in reticular-groove reactions. The question arises whether the transport of milk gulps out of the mouth cavity of the suckling calf is anatomically equivalent to swallowing. Maybe the nomination is merely anthropomorphic. The more there is no basis for the arbitrary use of the nominations sucking, suckling and swallowing.

During a substantial number of hours, the cisterns of the dams' mammary glands were full of already ejected milk, *i.e.* milk available for immediate ingestion. Thus a calf that had learned to grasp and suckle a teat could get milk at any time. Only when the cistern of the preferred quarter had been emptied once, the calf gathered the new experience that milk would be available only after the so-called pre-stimulation described by Zaks [1962]. The period of time between successful basic learning and gathering that experience were the happy hours of many of the calves observed and reported here. They made use of that period by ingesting a large number of small gulps rather than complete meals during day two *pp.*

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Pourodzeniowy test żywotności oparty na zachowaniu się ssących cieląt *Bos taurus*

Streszczenie

Badania przeprowadzono na 10 parach krowa-ssące cielę bydła mięsnego i 6 takich parach bydła mlecznego, rejestrując zachowanie się zwierząt między porodem a wyssaniem przez cielę pierwszej porcji siary. Określano zależność między pierwszymi próbami ssania i jego późniejszym przebiegiem a długością, średnicą, kątem ustawienia i odległością od podłogi każdego z czterech strzyków, obwodem wymienia, wysokością cielęcia w kłębie, rasą, numerem laktacji (*parity*), sposobem chwytania przez cielę ssanego strzyka i płcią cielęcia. Opisano trzy sposoby chwytania strzyka: "kąsanie", manipulowanie językiem i ssanie. Badane efekty pogrupowano, wyróżniając wpływ krowy, cielęcia, wymienia i strzyka. Wyróżniono także trzy podokresy pierwszego ssania: (i) od zakończenia porodu do pierwszego dotknięcia strzyka głową przez stojące cielę; (ii) od pierwszego dotknięcia strzyka głową przez stojące cielę do chwili wprowadzenia strzyka (podłużnie) do jamy ustnej (zależnie od sposobu jego chwytania) i (iii) od chwili, w której strzyk leży już podłużnie w jamie ustnej do pobrania (przełknięcia) znaczącej ilości pierwszej siary. Przedstawiono hipotezę oceny żywotności (VEH) podaną dla wyjaśnienia sensu nadwyżki mleka w wymieniu po porodzie i komentarza niezdatności wykazywanej przez pewne cielęta w jej pobieraniu.