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Mammalian *post-natal* test of vitality presented on a *Bos taurus* calves 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 studied were length, diameter, conicity and distance to the floor of each teat, girth of udder, withers height of each calf, then breed, lactation parity, type of teat grasping and sex. Three teat grasping tactics could be defined: biting, tongue playing and suckling. Effects were grouped, representing cow, calf, udder and teat. Three sub-periods were defined: (i) from end of parturition to the first touch of the standing calf's head with a teat, affected by lactation parity; (ii) from the first touch of the standing calf's head with a teat to the first teat was placed longitudinally in the calf's mouth, affected by teat grasping tactics, and (iii) from the first teat being placed longitudinally in the calf's mouth to the first ingestion of a substantial volume of colostrum, affected by teat conicity. A vitality evaluation hypothesis (VEH) is presented to explain the functional implications of a surplus of milk and the clumsiness of some individuals to ingest it.

KEY WORDS: calf / cow / colostrum / fitness / sucking / suckling

The placenta of some mammalian species (e.g. *Homo sapiens*) allows the passage of large molecules between the dam and foetus during pregnancy. In other species (e.g. *Bos taurus*) such *pre-natal* transfer of e.g. immunoglobulins is not feasible. Those species, therefore, need the oral transfer of antibodies from the mother shortly *post partum* (*pp*). Others (e.g. *Sus scrofa*) need additional 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*). In the text that follows, when emphasizing the general aspects of immediate *pp* ingestion, the terms “milk”, “mother”, and “offspring”, while when dealing exclusively with our model *Bos taurus* species, “colostrum”, “dam”, and “calf” are used.

An early supply with a substantial volume 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 volume of colostrum is necessary for the following reasons:

– the content of immunoglobulins in the colostrum decreases over time [Kruse 1970, Fallon 1979];
– the period during which the passage 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 immunoglobulins concentration of colostrum varied substantially between lactation parities. A calf from a primiparous dam could get too little immunoglobulins if it suckled from one teat only. However, a general shortage of the volume of milk suckled is not in accordance with the experience of farmers and zoo guardians. On the opposite, at birth there used to be a surplus of colostrum available in the mammary gland of many mammals, e.g. *Bos taurus* [Henkel and Mühlbach 1906], *Sus scrofa* [Castrén 1993], *Giraffa camelopardalis, Taurotragus oryx derbianus* and *Tursiops truncatus* [Amundin and Röken, personal information].

According to numerous reports there is a harmful delay in the first ingestion of colostrum [Derenbach 1981]. Possible reasons affecting that delay have been the subject of many studies and numerous factors were analysed, accordingly:

– behaviour of the dam [Selman *et al.* 1970a, Edwards and Broom 1982, Ventorp and Michanek 1991, 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, further referred to as “anatomy hypothesis” [Edwards 1982, Edwards and Broom 1982, Ventorp and Michanek 1991, 1992];
– breed [Selman *et al*. 1970b, Edwards 1982, Langholz *et al.* 1987, Le Neindre 1989];
– sex of the calf [Lidfors and Jensen 1988];
– difficult parturition [Edwards 1982];
– weight of the newborn [Langholz *et al.* 1987];

– own rearing conditions of the dam reported once to influence the ingestion of colostrums [Le Neindre 1989].

Thus, the availability of considerable volume of colostrum is not a guarantee for its early and sufficient ingestion *per se.* Observing the first attempts to ingest colostrum by a new-born calf, an observer cannot but be puzzled by the clumsiness of some individuals. Several attempts were made to analyse this immediate *post partum (pp)* behaviour of the calf by introducing sub-periods of activities between birth and first ingestion of colostrum. Derenbach [1981] mentioned two periods: from rising into standing position to the first occurrence of teat seeking movements and from the first occurrence of teat seeking movements to the first successful suckling and swallowing movements. Ventorp and Michanek [1991] presented overlapping activities: 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 to result in pendulous udders, or too low teat(s) position – 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" hypothesis Michanek [1994] cited reports about early suckling in wild species. The authors of the present report doubt whether those observations can be taken as a general rule for the following reasons: (i) observations from distance might often miss essential details; (ii) calves stillborn during night might be overlooked during daylight observations; and (iii) later but still close to *pp* losses might not be recorded. Our view is that the clumsy behaviour of the calf, and partially also of the dam when colostrum is abundant 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 to consider the hypothesis based on the assumptions given below.

(1) Production costs of a pregnant mammalian female 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 is a guarantee for the survival of a vital offspring.

(3) The offspring has to "proof" its vitality by overcoming difficulties before being able to ingest milk.

(4) The best period for an evaluation of offspring vitality is before the dam's heavy investment in lactation, *i.e*. during the immediate *post-natal* period.

We nominate the four points given above the "vitality evaluation hypothesis" further referred to as VEH.

The main objective of the research reported here was to present VEH by analysing the variation of the period from parturition to first ingestion of colostrum on a model data set. This main objective was partially hampered and 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 parturition and first ingestion of colostrum that were related to VEH *via* behaviour of dam and calf.

(2) To find potential new effects for analysis of variance of the sub-period mentioned in item (2) under the aspect of VEH.

(3) To select models for the analysis of variance of those sub-periods including as many as necessary of the new effects 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 literature.

Material and methods

Animals

General. Ten beef cow-calf pairs: nine Hereford and one Charolaise, were randomly selected from the herd of the Research Station for Ecological Agriculture and Endangered Animals Breeding, Popielno, Poland, belonging to the Polish Academy of Sciences. The management applied in that herd resulted in concentrated spring calvings. 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 parity of the dams thereby selected ranged from one to five.

Two years later, another six cow-calf pairs were selected from the dairy (Polish-Friesian) herd at the same Research Station and following the same procedure. The dairy herd was maintained on predominantly grass-based diet. Over the year preceding the observations it yielded about 5500 kg milk/cow.

Table 1 presents the sequence of births within each breed and gives 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 for beef cows was divided into single cubicles (5.5 m^2) with straw mats on the floor, 5-10 cm thick. During parturition and early lactation cows were loosely tethered within the cubicles with chains about 1.3 m long. 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 forthcoming recording period. The cows were not milked when the observations were in progress.

Thus, breed was confounded with management. Therefore, the special "breed-management-interaction" analysed here is further referred to 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 parturition happened during these hours video recording of that cow-calf pair was 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 allowed recording their frequency on the videotape.

Anatomical measurements

On the second day *pp*, the following measurements were taken and results recorded: length, diameter in the middle and conicity angle of each teat, distances of teat tips to the floor (further referred to as teat-ground-distance), udder girth (measured at teats' base) and wither height 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 hold in front of the teat.

Some of these measurements were summarized into the following additional potential effects: mean teat length, mean teat diameter and mean teat conicity.

Establishing of new sub-periods and new effects

Three to five observers viewed the video tapes in random order and at different speeds. Criteria for the establishment of new sub-periods between parturition 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, namely breed, lactation parity, sex and wither height of the calf. Wither height represented the vigour of the new-born to some extent.

Linear regression and Student's t-test were used to determine whether lactation parity, breed, and sex were confounded with anatomical measurements. Four following ways of grouping lactation parities 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 the lactation parity 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 principles and biological arguments mentioned below.

(1) The number of effects had to be minimized without hazarding the objective. Therefore, we grouped our final effects into four groups: those representing characteristics of the cow (breed, lactation parity), the calf (wither height, type of teat grasping, sex), the udder (udder girth, minimum teat ground distance) and the teat (mean teat length, diameter and conicity).

(2) 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 parity of dam were not systematically confounded in our data set (Tab. 1). Only teat-ground-distance was influenced by groups of lactation number (parity); the beef cows of the fifth lactation turned the regression into a second degree polynomial. The rougher grouping of lactation numbers, the less detailed the relationship between dependent and independent variables. No effect on any variable was seen in the roughest lactation grouping (d: ≤3, ≥4). There was no influence of the two lactation numbers of the dairy cows on any of the anatomical measurements.

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

Breed	Sex	Lactation No.	Type of teat grasping	Mean teat length	Minimum TGD	Mean teat diameter	Meat teat conicity (grades)	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

TGD – teat-to-ground distance.

Table 2. Anatomical dimensions across breeds and lactations

Variable	Mean for beef breeds, all lactations	Mean for beef breeds, lactation 3 and 4	Mean for dairy breed, all lactations
Teat length (mm)	57.9	58.8	58.8
Teat diameter (mm)	28.7	28.5	29.42
Teat conicity (grades)	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}
Wither height (cm)	71.4	73.8	70.83

TGD – teat-to-ground distance.
^{ab}Within rows means bearing different superscripts differ significantly at $P \leq 0.05$.

Dairy cows had lower minimum teat-ground distance and larger udder girth than beef cows (Tab. 2). These differences were 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 video tapes several times in random order and at different speeds resulted in distinguishing of three teat grasping tactics of calves. All examiners of the tapes expressed similar observations and classified the calves independently. The three teat grasping tactics observed are characterized below.

(1) According to tactics 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 suckling 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. A calf applying that tactics, we call a "biter".

(2) Other animals behaved in principal like biters. 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 call a calf applying that tactics, a "tongue player".

(3) 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 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 call a calf, applying that tactics, a "sucker".

We do not assume that the teat grasping tactics described here indicate genetic differences between individual calves. We interpret that the ethogram of a new-born calf is 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 the very first learning period of the teat grasping we found six tongue players, six biters and four suckers (Tab. 1). It was striking to observe the stubbornness an individual offspring stuck to its initial teat grasping tactics. 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. 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-tactics 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, however, still much closer to birth than to the peak of lactation. Majority of losses after the first third of lactation have other causes than a weak vitality of the offspring at birth.

New sub-periods

Three clearly distinguishable and measurable new sub-periods were found (given below) by repeated viewing of the video records at different speeds.

(1) From end of parturition, (*i.e.* from the moment when the calf 's body including legs was delivered completely) to the first touch of the standing calf's head with a teat (P1).

(2) From the first touch of the standing calf's head with a teat to the first teat was placed longitudinally in the calf's mouth (P2).

(3) From the first teat being placed longitudinally in the calf's mouth to the first ingestion of a substantial volume of colostrum (P3).

The following conditions had to be fulfilled to claim an ingestion of a substantial volume of colostrum: the suckled teat should be stretched and not bent sharply at the teat base and the calf should exert suckling movements with its mandible for at least 1 min uninterruptedly. The two former conditions are not automatically occurring simultaneously.

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 colostrum (P3), c: class variable, *r*: regression, lactation group ii: ≤2, =3, =4, =5

Period	Group effect	Effects and their character	R2 (model) resp. Prob. > F
P1			0.68; 0.008
	cow	breed, c	0.63
		lactation group b, c	0.0096
P2			0.8; 0.0007
	calf	wither height, *r*	0.65
		type of teat grasping, c	0.0006
		sex, c	0.65
P3			0.75; 0.0007
	teat	teat length, *r*	0.13
		teat diameter, *r*	0.02
		teat conicity, *r*	0.0003

c – class variable.
r – regression coefficient.

Table 3 summarizes the models chosen finally 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 lying down direct after parturition.

Biological arguments were intended to lead the search for the use of optimum 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 affected by one main effect: P1 by lactation parity, P2 by teat grasping tactics 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 sec. (about 77%, 22.9% and 0.1 % of the total period from end of parturition to the start of first ingestion of a vital volume of colostrums, respectively). The mean length of this total period was almost two hours, ranging from 1 to 3.3 h, and appearing slightly longer than that 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.

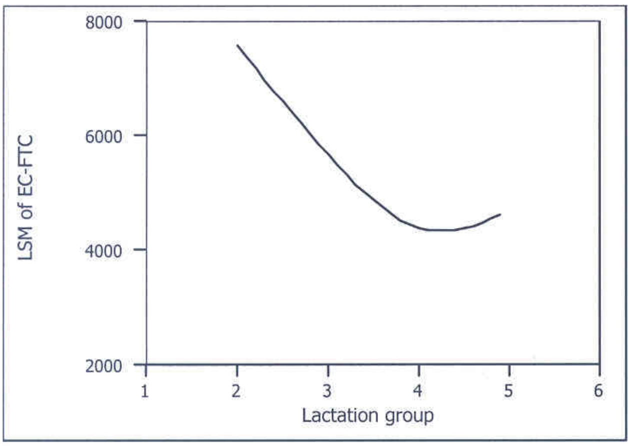

Fig. 1. Spline regression ($\lambda = 0.5$; $r^2 = 0.848$) between lactation group ii (lactation numbers: ≤2, =3, =4, =5) and least square means (LSM) of the period from end of calving until the first touch of the standing calf’s head with a teat (EC - FTC).

P1 was influenced to an overwhelming extent by the lactation parity. Figure 1 shows the effect of lactation group. Lactation parity 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 parity except for the beef cows in their fifth lactation. Thus, according to the anatomy hypothesis, P1 should become longer with increasing lactation parity. However, the results reported here appear opposite. Even the fifth lactation dams with bigger teat-ground distance than the fourth lactation dams, showed significant results opposite to the anatomy hypothesis. We prefer, therefore, to hypothesise that increasing experience of the dam shortened P1 until other age-dependent factors counterbalanced that experience. Those age-dependent factors might be, for instance, the 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 behaviour in the following ways.

(1) The dam takes a position relative to the seeking calf that exposes her udder especially by appropriate hind leg position and thus favours the offspring's teat seeking activities.

(2) The dam does not apply excessive care, e.g. strong anal licking during ongoing teat seeking efforts of the calf that is still very uncertain in standing position.

(3) The dam did not kick when the calf pushes 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 wither height does. 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 demonstrates how essential that teat grasping tactics was for the success of the calf. Its dam kicked violently whenever the calf touched the udder region. Very soon 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. At the end of day one *pp* she accepted contact between the head of the calf and her first suckled udder quarter.

Teat diameter and conicity affected 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 new-born 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 canal persisted. Such an animal (no. 7 from top in Tab. 1) was the only case in which the farm manager intervened. When the calf repeatedly tried to suckle the most conical teat of that dam unsuccessfully, he hand-milked a small volume of colostrum from that quarter: “They always try the same teat and especially that teat must be softer. Otherwise she won’t get any colostrum”. A suckling calf has to close the quarter cistern-teat passage 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 dimension traits, e.g. low teats or wide udders [Ventorp and Michanek 1992] had no substantial effect on the period from end of parturition to first ingestion of colostrum. Our data did not support the “anatomy hypothesis” despite that the lowest teats of our dams (Tab. 1) were even lower than those which Ventorp and Michanek [1992] reported to extent the period from parturition to ingestion of colostrum. However, the same authors claimed that low-positioned teats might be detrimental only in combination with other factors. Langholz *et al.* [1987] even reported that high-positioned teats of heifers hampered newborn calves. If significant anatomical effects were found in our data set, e.g. in P3, their effect on the total period from the termination of parturition to first ingestion of colostrum was very limited compared to the experience of the dam and the behavioural abilities of the calf.

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 according to which wild conditions are regarded as ideal, while domesticated ones as degenerated *per se.* That bias became clear when Michanek [1994] compared *pp* behaviour of wild follower populations, e.g. *Ovibos maschatus* [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 analysing 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 species, parental investment of which 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 dam and offspring have, in cooperation, to overcome difficulties in making 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 measures to prevent such losses.
(2) Most of such losses result from too late and(or) too little ingestion of colostrum.
(3) The majority of the cases identified in (2) show behavioural *pp* clumsiness.

An argument could be that VEH emphasizes the co-operation between dam and offspring. Indeed, VEH deliberately does not contribute to the question whether natural selection acts on the dam or the offspring [Birgerson and Ekvall 1997]. Male offspring of e.g. *Dama dama* emptied their dam's mammary gland faster (Birgerson, personal communication). This way 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 sucking female (half)-siblings and thus enhanced secretion during the ongoing lactation. This example emphasizes the co-operation between dam and offspring in the *post partum* vitality test. Such co-operation does not exclude controversion of interests between dam and offspring. However, "how or why progeny get 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 watched visually. Measuring milk ingestion during a suckling meal either needs high risk surgery of 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 is close to milk ingestion. We tried, therefore, to count movements of the oesophagus (see Material and methods). When the method described was applied, neither dam nor calf interrupted the suckling meal or changed observable behaviour. Some movements of the oesophagus should have been felt if the term "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 suckling, however, there is no evidence that this must be so. Mayntz [1996] reported that after-suckling lasted for at least 5 minutes. Lidfors *et al.* [1994] claimed that the calf in the post-suckling period is non-nutritive, at least partially. Rasmussen and Mayntz [1998] reported that sucking movements of the mandible were carried out *in vivo* with a frequency of 2 to 2.4 Hz. Thus, a swallowing frequency similar to that of sucking would have resulted in a minimum of 600 to 700 consecutive swallowing acts without substantial volumes of fluid. If, however, suckling and swallowing frequency differ, the latter ought to be slower. This view is supported by the results of Wise *et al.* [1984], who found much lower irregular frequencies in oesophageal 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 terms 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 2 of *pp*.

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

S t r e s z c z e n i e

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 niezdarności wykazywanej przez pewne cielęta w jej pobieraniu.