

Vocal behavior of resident killer whale matriline with newborn calves: The role of family signatures

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Studies of the vocal behavior of resident killer whales or orcas, *Orcinus orca*, in British Columbia have shown that matriline have unique call repertoires consisting of up to 17 different call types. These call types cannot be attributed exclusively to specific behaviors, and their function in social contexts is poorly understood. This study investigated the change in call patterns of three resident matriline in a changed social environment, before and up to one year after the birth of a calf. Acoustic data were collected with a network of hydrophones and were supplemented by visual observations. Call use changed distinctly after the birth of a calf in all three observed matriline. All call types that were recorded in control situations were also recorded in postbirth situations; however, aberrant versions of discrete calls and excitement calls made up a higher proportion of calls after birth. Most conspicuously, family-specific call types occurred significantly more frequently in the days following a birth in two of the three matriline and gradually returned to prebirth values within 2 weeks. Their increased use after a calf's birth may facilitate the learning process of this "acoustic family badge" and thereby help to recognize and maintain cohesion with family members. © 2006 Acoustical Society of America. [DOI: 10.1121/1.2130934]

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I. INTRODUCTION

All mobile species, in which associating with particular conspecifics is advantageous, must develop strategies to maintain group cohesion. This is particularly important if mothers and their dependent offspring frequently separate, e.g., during foraging trips (Janik and Slater, 1998). The fish-eating killer whales or orcas, *Orcinus orca*, in the coastal waters of the northeastern Pacific Ocean, termed *residents*, live in the most stable groups documented among mammals. Offspring of both sexes travel with their mothers throughout their lives, and dispersal from a family (hereafter termed "matriline") has not been documented in over 25 years of intensive observations (Bigg *et al.*, 1990; Ford *et al.*, 2000).

Resident orcas emit a variety of vocalizations, including echolocation clicks, tonal whistles, and pulsed calls. The most common vocalizations are "discrete calls," which are highly stereotyped pulsed calls that can be divided into distinct call types (Ford, 1989). Studies of the vocal behavior of residents showed that "pods," social units comprised of one or more closely related matriline, have unique vocal repertoires of 7 to 17 discrete call types (Ford, 1991; Strager, 1995). Moreover, acoustic similarities within groups apparently reflect common ancestry (Barrett-Lennard, 2000; Yurk *et al.*, 2002). Closely related matriline share most or all of their call repertoire, but may differ in relative production rate and certain structural variables of shared calls (Miller and Bain, 2000). Ford (1991) found that these dialects remain stable at the level of the vocal repertoire, since he detected

no differences in the call types used by selected groups over a 30-year period. None of the discrete call types showed a significant linear change in their relative production rate over a 16-year period (Presi, 2002). On a structural level, Deecke *et al.* (2000) detected significant changes in one of two studied call types over a 12–13-year period. Their study also showed that the call was modified in a similar fashion in the two studied matriline, thereby retaining the dialect differences between the groups.

Ford (1989) examined the role of discrete calls in the communication system of pods and found that no call type was exclusively associated with particular behavioral categories. He suggested that discrete calls function as signals to maintain pod cohesion and that the use of pod-specific signals enhances the efficiency of intrapod communication. Using the group's calls might provide an individual with an acoustic "badge" of pod affiliation, which could be important for its acceptance by the group and continued access to the benefits of group living. Also, individual- or group-specific signals may be used to discriminate between relatives and nonrelatives and might thus function as a mechanism for avoiding inbreeding (Sayigh *et al.*, 1990; Ford, 1991; Barrett-Lennard, 2000).

Vocal signals function in maintaining group cohesion in a variety of species (birds: Hausberger, 1997; primates: Elowson and Snowdon, 1994; cetaceans: Sayigh *et al.*, 1990; Weilgart and Whitehead, 1993; Janik and Slater, 1998), and a consensus is emerging that avian and mammalian species living in complex social environments have at least some vocalizations, generally used in affiliative contexts, that are responsive to changes in social environment. For instance,

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convergence of calls among birds within a flock has been reported for a number of species (Mundinger, 1970; Mammen and Nowicki, 1981; Nowicki, 1989). Pygmy marmosets (*Cebuella pygmaea*) of all age groups changed the structure of their trill calls when housed together with a novel group (Elowson and Snowdon, 1994), and Smolker *et al.* (1993) reported vocal convergence among a coalition of three male bottlenose dolphins. Captive bottlenose dolphins, that were voluntarily separated from their group, primarily produced individually distinct signature whistles. The remaining group also used primarily their signature whistles if one animal was in a separate pool, while the group used almost only nonsignature whistles when together (Janik and Slater, 1998). Similarly, bottlenose dolphin mothers and calves produced their signature whistles at high rates when forcibly separated in the wild (Sayigh *et al.*, 1990), and during voluntary separations calves often whistled as if to signal their intention to reunite with the mother (Smolker *et al.*, 1993). Social factors not only influenced use of signature whistles in juvenile and adult bottlenose, it also affected signature whistle development in bottlenose dolphin calves (see Tyack and Sayigh, 1997).

A study on the vocal development of a captive orca calf showed that the calf selectively learned some of its mother's calls, but none of the other unrelated pool mates' calls in the first year after birth (Bowles *et al.*, 1988). However, social influences on the use of discrete calls are poorly understood, since captive studies often cannot provide a naturalistic social background (see Caldwell *et al.*, 1990; Hausberger, 1997), and field studies of orcas face severe methodological limitations. Methods that allow assigning calls to known individuals are relatively new and difficult to apply (Miller and Tyack, 1998), and data collection in the wild depends on chance occasions, when situations are clearly definable and comparable.

The aim of the present study was to investigate the influence of the birth of a calf on the vocal repertoire of the three matriline (A12, A30, and A36) comprising A1 pod of the Northern resident community. Birthdates of several calves in all three matriline are known unusually precisely, and they also possess identified and easily distinguishable family-specific call types, which makes them ideal subjects for this study. In order to analyze these rare social events, acoustic data were collected with a network of permanent remote, radio-transmitting hydrophones and supplemented by visual observations.

II. MATERIAL AND METHODS

A. Study animals

The Northern Resident Community consists of more than 200 individually known orcas in three acoustic clans. It is regularly found in the study area of Johnstone Strait and adjacent waters off Vancouver Island, British Columbia, from July to October and occasionally through the rest of the year (Bigg *et al.*, 1990). New calves are observed every year but knowledge of precise birthdates is rare as most calves are born outside of the study area. A1 pod is the most commonly observed pod and consists of three matriline, named A12,

TABLE I. Life history parameters of the individuals belonging to A1 pod in the studied timeframe (1989–2002). ID numbers according to Ford *et al.* (2000). Max.age=maximum age of the calf (in days) when first seen. m = male, f = female, ? = unknown.

| Matriline | ID | Sex | Born–Died | Mother | First seen | max.age |
|-----------|-------|-----|-----------|--------|-------------------|---------|
| A12 | A12 | f | 1941 | ? | | |
| | A31 | m | 1958–1997 | A12 | | |
| | A33 | m | 1971 | A12 | | |
| | A34 | f | 1975 | A12 | | |
| | A55 | m | 1989 | A34 | 18 October 1989 | 0 |
| | A62 | f | 1993 | A34 | 01 November 1993 | 4 |
| | A67 | ? | 1996 | A34 | 10 November 1996 | 6 |
| | A74 | ? | 2000 | A34 | 09 October 2000 | 0 |
| A30 | A30 | f | 1947 | A2 | | |
| | A6 | m | 1964–1999 | A30 | | |
| | A38 | m | 1970 | A30 | | |
| | A39 | m | 1975 | A30 | | |
| | A50 | f | 1984 | A30 | | |
| | A54 | f | 1989 | A30 | | |
| | A72 | ? | 1999 | A50 | | |
| | A75 | ? | 2001 | A54 | 06 September 2001 | 1 |
| A36 | A36 | f | 1947–1997 | A1 | | |
| | A32 | m | 1964 | A36 | | |
| | A37 | m | 1977 | A36 | | |
| | A46 | m | 1982 | A36 | | |
| | no ID | ? | 1993–1993 | A36 | 20 November 1993 | 4 |

A30, and A36 (Ford *et al.*, 2000). Between 1989 and 2001 these were observed with a total of six newborn calves, whose birthdates were known with a maximum error of six days (Table I). In all cases, we assumed an age of one day for the day a calf was first sighted. The calf born to A36 in 1993 did not live long enough to have an ID number assigned.

B. Field observations and recordings

Visual and acoustic data were obtained at the research station OrcaLab on Hanson Island, which is located centrally in the study area. Additional visual data were obtained through a network of observers: OrcaLab volunteers stationed at field stations, other independent researchers, and whale watch operators. All data were reconciled daily. The waterways were routinely surveyed with spotting scopes; visual observations were done on an opportunistic basis, whenever whales were seen or heard within the vicinity of a station. Upon sighting, the number and identity of individuals (Ford *et al.*, 2000), group composition, group cohesion, direction of movement, and behavioral state (travel, motionless, forage, or socialize) were recorded. As long as whales were within visual range, changes in any of the above parameters, as well as times when the whales passed key landmarks, were noted.

Acoustic data were collected with a network of up to six radio-transmitting, various custom-made hydrophone stations (overall system frequency response 10 Hz to 15 kHz) monitoring the underwater acoustic environment of the area continuously, 24 hours a day and year-round (Fig. 1). At OrcaLab, the mixed output of radio receivers tuned to the specific frequencies of the remote transmitters was recorded on

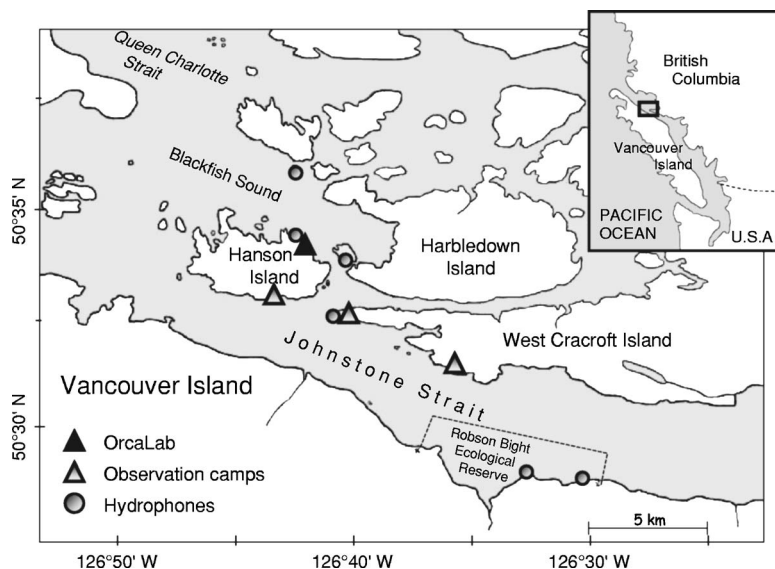


FIG. 1. Summer core area of the Northern Resident community with land-based observation sites and the OrcaLab hydrophone network.

a two-channel audio cassette recorder (Sony Professional Walkman WM-D6C or Sony TCD-D3), whenever whales were vocal. Use of mixer controls allowed distinction of hydrophone stations and thus basic tracking of group movements. Mixer settings were recorded in logbooks together with acoustic and visual information.

C. Acoustic analyses

We analyzed all available recordings of focal matriline traveling with a young calf of known age, as well as recordings of the A30 matriline when they returned into the study area in the summer after A75's birth. We only used recordings for further analysis that allowed definite attribution of calls to the respective matriline. This excluded night-time recordings as well as those where one or more additional matriline were seen and/or heard within range of the same hydrophone as the focal matriline. As controls we chose recordings of the same matriline with no calves younger than 1 year present. These were chosen from several different days, where no other than the focal matriline was present in the core recording area. The predominant behaviors in the selected recordings were foraging or traveling.

Calls were classified by simultaneous acoustic and visual inspection of sonagrams, generated with Cool Edit 2000 (Syntrillium Software Corporation) or Raven 1.2 (Cornell Lab of Ornithology). Call classification followed that of Ford (1987, 1989, 1991), with the addition of two call subtypes: a rendition of call N5 (Ford, 1987), hereafter termed N5iii, and a subtype of the N9 call, hereafter termed N9iv, that was not previously described by Ford (see Sec. III and Figs. 5 and 6).

D. Statistical analyses

Recordings with more than 5% of calls not both visually and acoustically recognizable because of poor signal-to-noise ratio were excluded from statistical analysis to avoid a bias towards call types of higher amplitude (see Miller and Tyack, 1998). The remaining data were split into samples of 100 continuous calls. To increase the data set, we also included recordings in which less than 100, but a minimum of

75, calls remained after final selection. We determined percentages of call use per call type and sample. Data were analyzed using the SPSS® statistical program (Pfeifer, 1991). Data were $\log(x+1)$ transformed and tested separately for each matriline with multivariate ANOVAs comparing call rates across ages. For the A12 matriline, we used the identity of the calf as a covariate. Where necessary, we used Bonferroni *posthoc* corrections. For *posthoc* tests, A30 data for days 4+5, 15+20, 73+74, as well as 332–365 were pooled because of insufficient sample size. Duration and frequency of N9 subtypes were not normally distributed (Shapiro-Wilk, all parameters $p < 0.05$) and were compared with Mann-Whitney U test. All statistical tests were two tailed.

III. RESULTS

A. Basic call patterns

Call patterns in the absence of young calves did not differ markedly from those described by Miller and Bain (2000). The most frequent call types in all three matriline were types N4 and N9. Call types N11, N12, N13, and N27 were included in the category "other" [Figs. 2(a), 3(a), and 4(a)] because of their low rate of occurrence (usually less than 0.5%) in any context. Call type N47 is specific to the A1 pod (Ford, 1989) and therein almost exclusively produced by the A30 matriline. All three matriline, but in particular the A12 matriline, produced a rendition of call type N5, first described by Ford (1987). This N5iii, also known as "A12special" among local researchers, is a relatively long call ($\bar{X} \pm SD = 1.18 \pm 0.13$ s, $n = 23$) with a sharp initial rise of the fundamental of the repetition rate to 1118 ± 63 Hz and a gradual rise to 1709 ± 185 Hz (Fig. 5). The call repertoire of the A36 matriline was characterized by a high proportion of N5 calls and the exclusive use of subtype N9iv. Compared to the A1-typical N9 (see Ford, 1989), N9iv is significantly shorter (N9iv: $\bar{X} \pm SD = 0.69 \pm 0.06$ s, $n = 15$; N9i: $\bar{X} \pm SD = 0.91 \pm 0.05$ s, $n = 8$; MWU: $Z = -3.81$, $n = 23$, $p < 0.001$) and, after the initial buzz, shows a steeper rise towards the

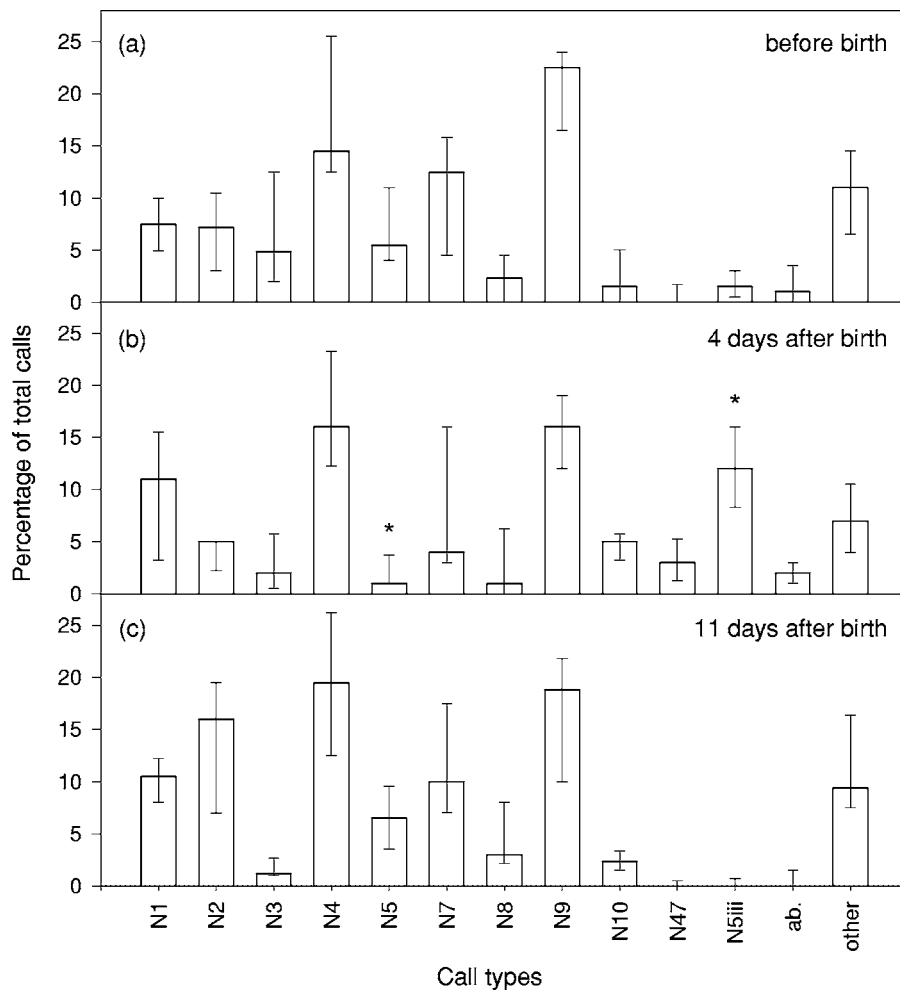


FIG. 2. Call use of the A12 matriline (a) before the birth of a calf, (b) four days after the birth of the calf A74, and (c) 11 days after birth of the calf A67. N(1–47)=call types after Ford (1989). ab.=aberrant. Bars show median percentage of total calls and first and third quartiles. Asterisks mark significant differences to prebirth values: * $p < 0.05$. N (calls)=(a) 782, (b) 814, and (c) 374.

end (N9iv: from 1419 ± 76 Hz to 2118 ± 45 Hz, $\bar{X} \pm \text{SD}$; N9i: from 1165 ± 44 Hz to 1385 ± 47 Hz, $\bar{X} \pm \text{SD}$; MWU: $Z = -3.88$, $n = 23$, $p < 0.001$), which gives it a “squeaky” quality (Fig. 6).

B. Call patterns after the birth of a calf

1. A12 matriline

Eight control samples from six different days and 15 samples for four different calves, spanning from an age of 3 to 11 days, were of sufficient quality to be further analyzed. Age of the calves significantly influenced the occurrence of call types N5 (ANOVA: $F_{5,22} = 3.469$, $p = 0.024$) and N5iii (ANOVA: $F_{5,22} = 6.284$, $p = 0.002$). The identity of the calf had no significant effect (ANOVA: $F_{14,3} = 2.059$, $p = 0.302$). Sample numbers only allowed *posthoc* comparisons between recordings before birth [Fig. 2(a)] and recordings at ages of 4 days [calves A62+A74, Fig. 2(b)] and 11 days [calf A67, Fig. 2(c)]. N5 calls made up a significantly smaller proportion of calls 4 days, but not 11 days after birth as compared to prebirth recordings ($F_{2,19} = 5.469$, after Bonferroni correction: control vs. 4 days: $p = 0.016$, control vs. 11 days $p = 1.0$). On the contrary, N5iii calls were used significantly more frequently when 4-day-old calves were present than before or 11 days after birth. Values did not differ significantly before and 11 days after birth ($F_{2,19} = 8.201$, after Bonferroni correction: control vs. 4 days: p

$= 0.03$, 4 days vs. 11 days: $p = 0.005$, control vs. 11 days: $p = 0.548$). Also, there was a tendency for aberrant calls to occur more often 4 days after birth ($F_{2,19} = 3.495$, control vs. 4 days: $p = 0.082$).

2. A30 matriline

The most extensive data set was available for the calf A75, with 19 samples from 10 different control days and 47 samples for ages of 1 to 365 days. The matriline showed significant variation in the use of call types N2, N7, N10, and N47, aberrant calls as well as excitement calls at different ages of the calf; because of the large number of aberrant N47 calls, we analyzed them separately from other aberrant calls (N2: $F_{11,65} = 3.037$, $p = 0.003$, N7: $F_{11,65} = 2.046$, $p = 0.041$; N10: $F_{11,65} = 5.500$, $p < 0.001$; N47: $F_{11,65} = 6.584$, $p < 0.001$; N47 aberrant: $F_{11,65} = 5.321$, $p < 0.001$; other aberrant calls: $F_{11,65} = 2.319$, $p = 0.020$; excitement calls: $F_{11,65} = 3.381$, $p = 0.001$). Most strikingly, the use of N47 calls increased dramatically on the first day after birth and gradually returned to prebirth values within 2 weeks (Fig. 3, Table II). Also, excitement calls were almost absent from all recordings except for day 1 after birth. The use of N10 calls did not differ from controls in the first 2 days following the birth but increased significantly thereafter and remained elevated even 1 year later (Fig. 3). N2 calls occurred significantly less often 1 day and 1 year after birth, but not in between. *Posthoc* analyses

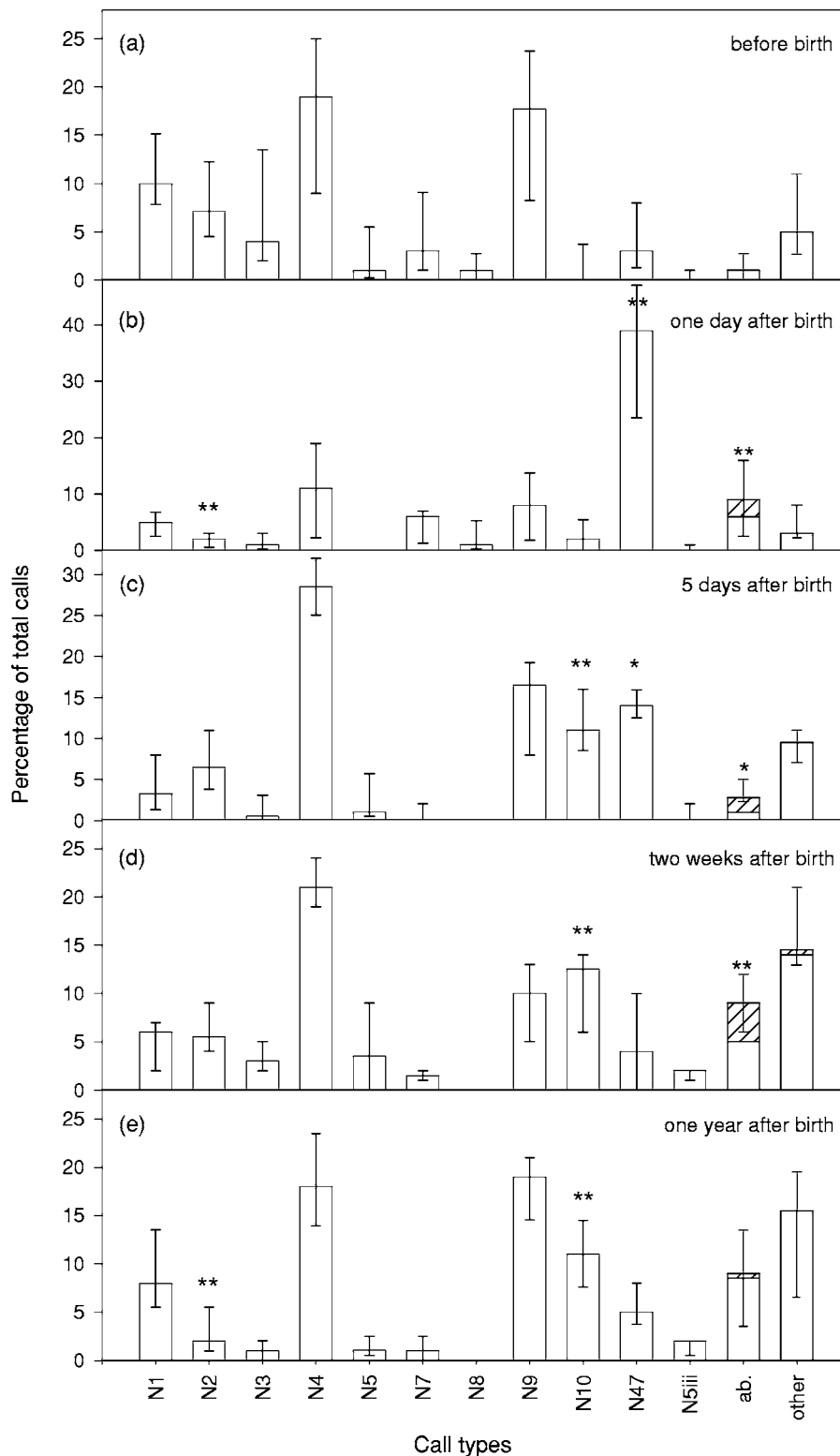


FIG. 3. Call use of the A30 matriline (a) before the birth of a calf, (b) 1 day, (c) 5 days, (d) 2 weeks, and (e) 1 year after the birth of the calf A75. N(1–47)=call types after Ford (1989). ab.=aberrant. Hatched portions of aberrant calls indicate the proportion of aberrant N47s, hatched portions of other calls indicate the proportion of excitement calls. Bars show median percentage of total calls and first and third quartiles. Note the different scalings on the y axis. Asterisks mark significant differences to pre-birth values: *= $p < 0.05$, **= $p < 0.01$. N (calls) = (a) 1859, (b) 1181 (c) 377, (d) 600, and (e) 1186.

revealed no further statistical differences between ages for call type N7 and for aberrant calls, except for aberrant N47s, which occurred significantly more often in the first 2 weeks after birth (Fig. 3 and see Table II).

3. A36 matriline

Data selection yielded 12 prebirth samples from 11 different days and 5 samples from 20 November 1993, when the A36 matriline was observed traveling through Blackney

Pass with a newborn calf. In the presence of the calf, excitement calls (Ford, 1991) made up the highest proportion of produced calls with almost 20% (Fig. 4), while they usually were emitted at less than 0.5% ($F_{1,16}=80.220$, $p < 0.001$). Also, the use of aberrant calls increased significantly when the calf was present ($F_{1,16}=9.475$, $p=0.008$). Rates of N3 calls and N8 calls were found to be significantly lower when the matriline was traveling with the calf than in control situa-

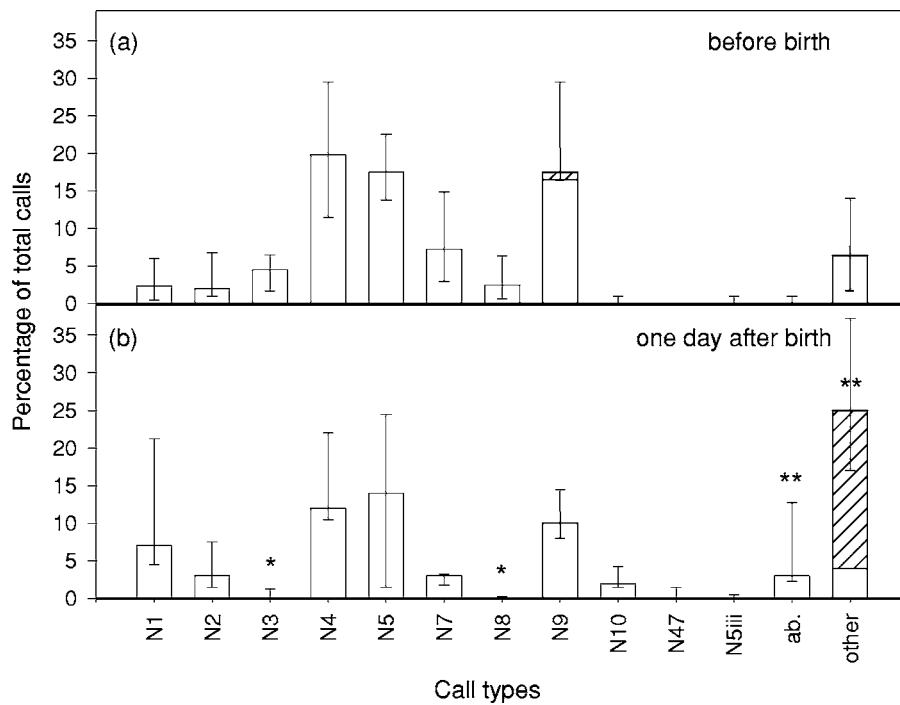


FIG. 4. Call use of the A36 matriline (a) before the birth of a calf and (b) 1 day after the birth of a calf. N(1–47)=call types after Ford (1989). ab.=aberrant. Hatched portions of N9 calls indicate the proportion of A36-specific subtypes; hatched portions of other calls indicate the proportion of excitement calls. Bars show median percentage of total calls and first and third quartiles. Asterisks mark significant differences to prebirth values: * = $p < 0.05$, ** = $p < 0.01$. N(calls)=(a) 1128 and (b) 500.

tions (N3: $F_{1,16}=7.805$, $p=0.014$; N8: $F_{1,16}=6.941$, $p=0.019$).

IV. DISCUSSION

A. Comparison between matriline

In all three studied matriline we observed distinct changes in call use in the days after the birth of a calf. The most striking difference was the dramatic increase of the family-typical call N47 in the A30 matriline 1 day after the calf A75 was born. N47s were the most frequently used calls when the calf was 1 day old, with N47—call rates dropping gradually in the following days. They were still significantly higher than before birth on day 4–5, but were back to normal after 2 weeks. This fits well with the pattern found in the A12 matriline. Again, the use of the family-specific call, N5iii, was affected by the birth of calves. When the family was recorded 4 days after the birth of A74, they emitted their

family-typical call at similar rates as the A30s did when A75 was 4–5 days old. Another calf born into the A12 matriline, A67, was 11–16 days old when the family was recorded on its own and, as in the A30s, the family-specific call type was no longer used at higher rates than before birth. Among the 88 calls analyzed when A55 of the A12 matriline was 3 days old, there was not a single A12special. It is possible that the N5iii call subtype only became noticeable as the family grew in number with successive calves and became more independent of the other A1 matriline, but this idea remains yet to be tested. In a recording of the A12s with A62 at an age of 8–11 days, the A12special was still the second most frequently used call type. However, for the latter two calves, sample sizes were too small to be taken into account on their own.

In contrast to the A12s and A30s, the A36 matriline did not increase the use of their “family badge,” N9iv, but instead showed a very high rate of excitement calls. An in-

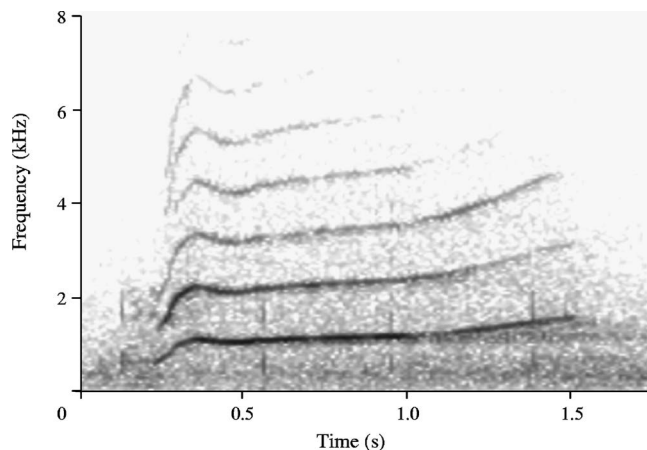


FIG. 5. Sonogram of call subtype N5iii, produced by the A12 matriline, with a filter bandwidth of 64.5 Hz.

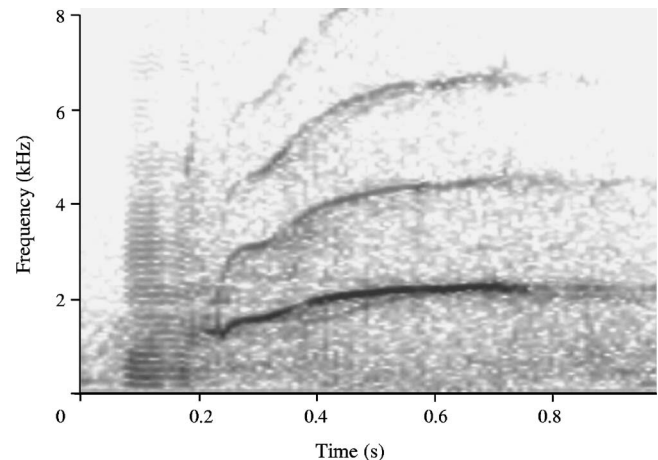


FIG. 6. Sonogram of call subtype N9iv, produced by the A36 matriline, with a filter bandwidth of 82.4 Hz.

TABLE II. Significant differences in A30 call use before and several days after birth (day 1–365). >: call rates higher than on, <: call rates lower than on, *p* values are Bonferroni corrected. N47 ab.=N47 aberrant, exc.=excitement calls.

| Call type | day | | day | <i>p</i> |
|-----------|----------|---|-----|----------|
| N2 | prebirth | > | 1 | 0.001 |
| | prebirth | > | 365 | 0.005 |
| N10 | prebirth | < | 5 | 0.001 |
| | prebirth | < | 15 | <0.001 |
| | prebirth | < | 73 | 0.002 |
| | prebirth | < | 365 | <0.001 |
| | 1 | > | 5 | 0.019 |
| | 1 | > | 15 | 0.004 |
| | 1 | > | 73 | 0.04 |
| | 1 | > | 365 | 0.001 |
| N47 | prebirth | < | 1 | <0.001 |
| | prebirth | < | 2 | 0.004 |
| | prebirth | < | 5 | 0.032 |
| | 1 | > | 15 | <0.001 |
| | 1 | > | 73 | 0.005 |
| | 1 | > | 365 | <0.001 |
| | 2 | > | 15 | 0.004 |
| | 2 | > | 365 | 0.061 |
| N47 ab. | 5 | > | 15 | 0.026 |
| | prebirth | < | 1 | <0.001 |
| | prebirth | < | 2 | 0.002 |
| | prebirth | < | 5 | 0.028 |
| | prebirth | < | 15 | 0.001 |
| | 1 | > | 73 | 0.045 |
| exc. | prebirth | < | 1 | <0.001 |
| | 1 | > | 2 | 0.023 |
| | 1 | > | 5 | 0.003 |
| | 1 | > | 15 | 0.007 |
| | 1 | > | 73 | 0.003 |
| | 1 | > | 365 | <0.001 |

crease in excitement calls was also observed in the A30s 1 day after the birth of A75, but the change was not nearly as strong as in the A36s. A general state of excitement after a birth likely is one reason why we observed elevated rates of aberrant calls in all three matriline. Bowles *et al.* (1988) observed a variety of vocalizations not yet resembling discrete call structure in a captive orca calf at an age of 12–15 days. While not able to produce “proper” call types yet, the calves in this study may already have produced aberrant versions of discrete calls.

Other changes affected call types N2, N3, and N8, which all decreased in use in the days following birth, but otherwise showed no obvious pattern between matriline. Likely one explanation is the significant increase of usually only infrequently used call types, which necessarily caused other call types to make up smaller proportions of overall calls than in the usual call repertoires. Only in the A30 matriline we observed an increase of call type N10 by day 5 and in any recordings thereafter. Rates of N10s were still higher than before birth at the end of the study, one year after the birth of A75. While all the short-time changes were very likely caused directly by the birth of a calf, it is difficult to

say whether this long-time change was, too, or whether it was an independent shift in the A30s call pattern (Presi, 2002) that just coincided with the birth of A75.

B. Signature signals and family badges

Group- or individual-specific vocal signals are effective means of maintaining contact with group members (f.i. bats: Boughman and Wilkinson, 1998), especially in the aquatic environment, where visual signals can only serve in short distance communication. Orcas, as well as other cetacean species, however, often separate over distances of several hundred meters or more during foraging (Ford *et al.*, 2000) and need reliable means for maintaining or reestablishing spatial proximity. Bottlenose dolphins, for instance, rely on signature whistles with individually distinct frequency contours (see Tyack, 1997), while sperm whales use group-specific rhythmic click patterns called codas (Weilgart and Whitehead, 1997). Ford (1989) suggested that also the family-specific vocal dialects of the studied population of resident orcas serve that function. Resident orcas frequently come together in large aggregations where several matriline are present at one time and engage in a high degree of social activity and movement. Group- or individual-specific vocal signals might therefore help ensure that individual members can locate and coordinate with other family members. Social communication and coordination with members of other groups would likewise be ensured and further enhanced. The family-typical call types or subtypes seem to be particularly well suited for this task.

Maintaining contact with its mother is of critical importance for a young calf. Orca calves can swim well at birth and may become separated by tens of meters from their mothers, on whom they are completely dependent. For instance, bottlenose dolphin mothers and calves both whistle at high rates when temporarily separated (Sayigh *et al.*, 1990). It is thus not surprising that the most obvious change we observed in the vocal patterns of the studied matriline was generally a dramatic increase in the use of their most distinct calls. Both in the A12 and in the A30 matriline this effect ceased after approximately 2 weeks. It is very unlikely that the calves were able to produce these calls at that point in time: A captive orca calf was first found to produce discrete call types at an age of 1 year (Bowles *et al.*, 1988). Neonate sperm whales produce clicks that are very different from adult clicks (Madsen *et al.*, 2004), whereas older animals use patterned click sequences that more closely resemble adult codas (see Weilgart and Whitehead, 1997), and even bottlenose dolphin calves only develop distinct signature whistles at an age of 1.5–2.5 months of age (Caldwell and Caldwell, 1979). However, a high exposure to the family-specific call type in the first days after birth may enhance its recognition and thereby facilitate keeping up or reestablishing spatial proximity between calves and their mothers or other immediate family members. This may become increasingly important when infants begin to separate further away from their mothers (Smolker *et al.*, 1993; Baird, 2000). It remains crucial even later in life, as resident orca offspring bond with their mother for life and dispersal from the natal group has

not been documented in over 30 years of research (Barrett-Lennard, 2000, Ford *et al.*, 2000, OrcaLab, unpublished data).

The importance of acoustic and other social factors in vocal acquisition has been documented in a variety of species (e.g., birds: Baptista and Gaunt, 1997; cotton-top tamarins *Saguinus oedipus*: Snowdon *et al.*, 1997), including cetaceans (see Tyack and Sayigh, 1997). For instance, those wild bottlenose dolphin calves that showed higher levels of synchronized surfacing with their mothers during the period of whistle development developed their signature whistles more rapidly than others. Bottlenose dolphin calves whose acoustic environment consisted mainly of their mothers' signature whistle had a more rapid whistle development than calves being less exposed to the mother's signature (Tyack and Sayigh, 1997). Also, the captive orca calf studied by Bowles *et al.* (1988) learned its mother's most frequently used call types faster than other call types. Studying the vocal behavior of matriline and newborns might lead to more in-depth investigations of what happens to vocal behavior when an individual is separated from its group temporarily. On one occasion, the adult male A6 from the A30 matriline was observed trailing his family who had travelled about 2 km ahead and, upon following, the separated male emitted the family-specific N47 call continuously (Spong *et al.*, 1993). Detailed analyses of such rare events promise further important insights into the role of family dialects for maintaining and reestablishing family bonds.

In conclusion, births of calves into resident orca matriline were followed by a general state of excitement as well as a dramatic increase in family-specific call rates. This supports the idea that discrete calls in orcas indeed function as family badges and suggests that the family may actively enhance vocal learning of a signal that is crucial for recognizing and maintaining contact with the family.

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