

ACOUSTIC REPERTOIRE OF LONG-FINNED PILOT WHALE IN THE NORTHWESTERN MEDITERRANEAN SEA.



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Delphinids are met worldwide in social groups of variable complexity. Within social units, contact between individuals is obtained through communication, including vocal repertoire for short to long range communication. Variable school activity can also be coordinated with sound, either vocal or non vocal (breaching, tail of flipper slapping). Among the most gregarious odontocetes, the long-finned pilot whale (*Globicephala melas*) performs numerous vocalizations (clicks, whistles, pulsed chirps) and is known to be the only Mediterranean species to emit pulsed calls. However, in spite of early studies

in the North Atlantic Ocean (Weilgart & Whitehead, 1990), very few results are available for the pilot whale in the Mediterranean Sea. This study presents a preliminary repertoire of long-finned pilot whales in the NW Mediterranean Sea, obtained from a set of sailboat data obtained during 1990-1995 period. Moreover, as the pilot whale is thought to rely on long term stable associations, we tried to determine if this repertoire might be partly group specific.

MATERIAL AND METHODS

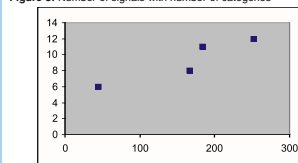
To sample pilot whales vocalizations, we used 200 Hz-20 kHz hydrophones, either simple or towed array, and analog (1990-1994) or DAT recording devices.

Our methodology includes three main stages :

- all available recordings from 1990 to 1995 were georeferenced derushed with 90 secondes bins and described in an Access data base comprising the following fields : references of the sighting linked with the recording (date, hour, latitude, longitude, sighting number...), the tape reference number, species, the different types of signals (clicks, whistles, squeals...) classified in order of importance (occurrence) in the sequence , level of noise and level of signals (five levels scale), and vocalisations quality (three levels scale). This stage permitted a precise and exhaustive material description (18 cassettes for the five years with a 75 min average recording duration for each tape)
- all good quality vocalizations were digitized (software Cool Edit Pro2) at 32 kHz-16 bits in 90 secondes sequences to warrant easy access to data in link with the data base
- every single tonal signal (whistle or call) provided one sample from which a FFT-spectrogram was produced (Figure 3) and the following variables extracted: duration, beginning and end frequencies, type of frequency modulations, number of harmonics

A total of 647 tonal signals coming from 4 different sightings (one for 1990, 1994 and two for year 1995) were processed and sorted into 19 categories and 90 sub-categories using the variables defined above (Table 1).

Figure 3: Number of signals with number of categories



Every category was assigned a type (A to S) and determined with average values for the variables and a direct link to the « type vocalization » was provided, together with the « type spectrogram ». Every category provided a variable number of sub-categories (1 to 20).

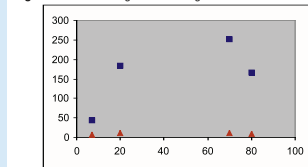
Table 1: Repertoire's categories and their different descriptive variables.

Categories	Sub-categories	Duration (sec)	Beginning freq (Hz)	End freq (Hz)	Freq modulation	Number of harmonics	Category freq (%)
A	1	0.46	2150	1000	simple	10	0.2
B	3	0.392	975	2365	simple	5	0.6
C	5	1.08	1930	2350	dbble repeated	4	11.4
D	4	0.807	1510	2525	dbble repeated	2	2.9
E	2	0.703	2325	2650	triple	4	6.7
F	1	0.213	1200	1050	simple	6	0.9
G	2	1.67	900	1000	double	99	1.6
H	3	0.796	4815	1715	double	4	6.5
I	2	1.17	5975	4000	double	2	2.1
J	9	0.83	3885	3695	simple	2	11.1
K	6	0.66	2635	2065	triple	3	3.9
L	2	1.04	1650	1950	simple	5	3.6
M	20	0.121	2130	2125	simple	2	22.3
N	7	1.164	2220	1715	double	3	9.6
O	5	0.445	2540	6960	simple	1	8.5
P	1	0.74	1500	2000	simple	9	2.2
Q	2	1.23	1350	2175	simple	4	1.9
R	9	2.582	6015	5540	dbble repeated	1	1.7
S	5	0.913	1270	1350	double	7	2.3

RESULTS AND DISCUSSION

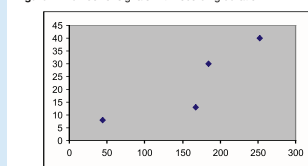
Generally, the repertoire included whistles and frequency modulated tonal vocalizations in the range 730 Hz to 16 kHz with most signals between 2 and 14 kHz. Signal duration was very variable (64ms to 4529ms), as was relative intensity and harmonic structure (ranging from one to more than ten harmonics). Rich harmonic structure are characteristic of the species with vocalisations like squeals, squeaks, whines. The latter signals are generally repeated several times by an individual over a duration of one minute or more.

Figure 1: Number of signals and categories with school size.



The number of signals derived partly from

Figure 2: Number of signals with recording duration

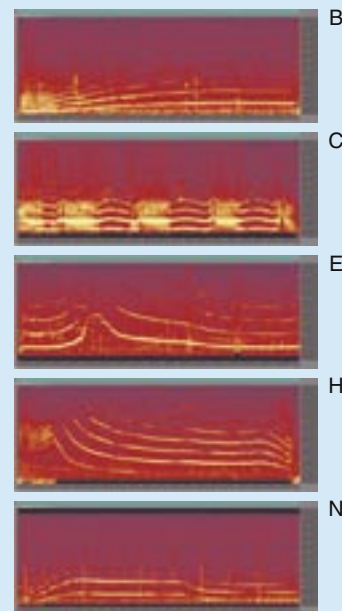


The repertoire's study shows that four categories amounted to 55 % of the signals and were represented in four sightings. Recordings from three sightings displayed each more than 8 different sound types (categories). The number of signals derived partly from the school size as was the case for the number of categories (Figure 1). More, a clearer relationship was obtained by comparing the number of signals and the recording duration, between 8 and 40 minutes (Figure 2). This implies that field

studies to determine the pilot whale = repertoire should preferably include long recording session (t > 30 minutes) in order to get the widest sample possible from a given group. But in spite of a wide variety of emissions, the majority of sounds belonged to a more restricted domain : two signal categories were common to 4 sightings and four categories were shared by 3 sightings. There was evidence for a basic repertoire common to Mediterranean pilot whales.

On the other hand, there were vocalizations emitted by only one or two groups of pilot whales. This might be a result of a particular behavioral state, or to a given social context. Most animal vocalizations are known to have a communication function partly induced by the context in which they are emitted (Clark, 1983; Silber 1986; Tyack 1981). This might also be an indication that some groups may use partly specific repertoire, as is known form *Orcinus orca* in British Columbia (Ford, 1991). As a matter of fact, recordings and spectrograms of discrete calls (a form of pulsed calls most associated with foraging and traveling) of killer whales in waters reveal acoustic signals with very similar characteristics of those we found in our repertoire. For this species, each pod has a group specific repertoire of discrete calls that is stable for many years. No pods share a common call repertoire of the (Ford 1991, Strager 1995). These group-specific repertoires are thought to indicate pod affiliation, maintain pod cohesion, and coordinate activities of pod members. Production of the calls would allow dispersed subgroups of foraging whales to keep track of each others location. After several pods have finished foraging together, they may use their group-specific repertoires to regroup into the original pods (Ford, 1989).

Figure 4: FFF spectrograms (frequency/time) representative of 4 categories : respectively B, C, E, H and N.



CONCLUSION

The first result of the study was to bring knowledge on pilot whale vocalizations in the north-western Mediterranean, indicating an great variety in signals, including « pulsed calls » involved in social communication. More, there was preliminary indication that signals could be partly group specific, although further analysis are needed by taking account of group structure and

behavioral context. A perspective would be a complementary study including the behavioral cues seen from the surface and variables describing the social structure (males, females with calves). Additionally, a comparison with other pilot whale populations may eventually indicate if a population dialect exists, as was shown for *Orcinus orca* in the northeastern Pacific.

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ACKNOWLEDGEMENTS

We thank all members of GREC who benevolently participated to survey or brought their help (assistance) to carry this study to a successful conclusion.