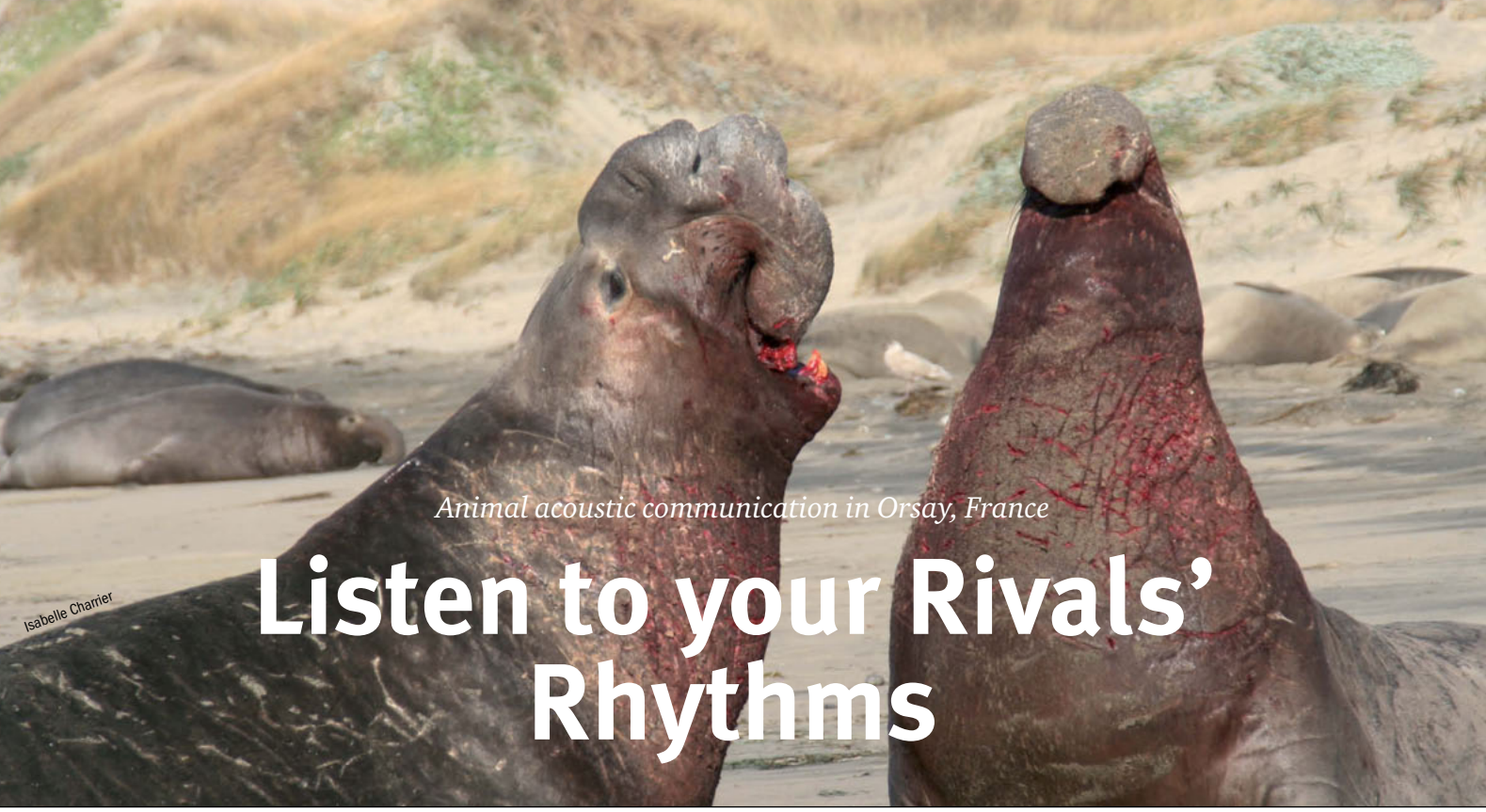

Isabelle Charrier

Animal acoustic communication in Orsay, France

Listen to your Rivals' Rhythms

For northern elephant seal males, competition is intense during mating season. But Isabelle Charrier and colleagues have recently discovered one of their secrets: memorising the voices of their rivals.

Every winter, northern elephant seals make their way to the beaches along the west coast of North America after spending most of the year in the Pacific Ocean: it's breeding season. Males arrive first, in early December. Those days alone, without the females, shape the social hierarchy, defining the mating success of each one of them later in the season. Females come ashore around mid-December and, those who are pregnant, give birth soon after their arrival. They nurse their single pup for about forty days and will accept copulation only at the end of the lactation period. Therefore, it's from mid-February to early March when the mating finally takes place and the dominant males can enjoy the status for which they have fought.

This individual social status is partly established, based on the outcome of physical confrontations between them. But these heavy creatures cannot afford to be constantly fighting. It is costly and bloody; tougher, given the long period of fasting imposed on them during the whole breeding season, as they do not leave the land to forage at sea. Thus, during these early physical encounters, they also interact using other cues.
Being able, later, to use these signals to identify the social rank of the rival, without engaging in a fight, might be handy.

Colleen Reichmuth

On a Californian beach in winter: Isabelle Charrier (3rd from right) and the rest of the seal team.

Seals and their noisy recognition system

One of the signals used by these males is vocalisation: a series of loud claps that are part of the encounter ritual between them. Isabelle Charrier, an associate researcher at the Paris-Saclay Institute of Neuroscience in Orsay, France, together with colleagues from the Bioacoustics team in France (a group of researchers based in Orsay and Lyon, working in different areas of vocal communication) and scientists from the University of California, Santa Cruz in the USA, want to understand how these acoustic cues allow recognition among members of these colonies. Charrier herself has been interested in this type of communication for almost two decades. After a PhD, focussed on studying mother-pup vocal recognition in fur seals, she has devoted her research to understanding vocal communication in pinnipeds, the clade to which seals belong.

Pinnipeds look like a good model for studying vocal communication: they appear to be quite noisy! But Charrier's interest in these animals is also due to another aspect. "They are very good mammalian models because different species show different social structures. You can find pinniped species that are almost solitary, while others are highly colonial: there is a huge scale in the social structure," she explains. It's the same with their breeding system: you'll find monogamous species, like the spotted seal, and highly polygynous ones, such as the northern fur seal. Charrier is, hence, interested in studying how social structure in pinnipeds shapes their recognition system. She has been involved in projects researching olfactory and visual recognition but focusses mainly on vocal communication as she believes acoustics is probably "the most efficient sensorial modality" in this context.

All guys are not the same

The northern elephant seals (*Mirounga angustirostris*) belong to the social and polygynous type. While on land, males

establish the social hierarchy that determines the role of each of them within the female harems. For each harem or group of females, there is one alpha male – the highest rank, the lucky one with the best access to females – and a group of beta mid-ranking males that try to steal the position from the alpha males. These beta males are usually found in flanking positions relative to the female congregations. A third group are the younger sub-adult males, also known as peripheral as they stay outside the harem. "They are watching and learning about the male strategy but always avoiding the big males. Sometimes they sneak into the harem and try to mate with the females but they are not really successful," Charrier explains.

The competition for the females, thus, takes place mainly among the big guys. The fights are more common at the beginning of the season, when they establish their social status, and also at the very end, "It's their last chance to mate," affirms Charrier. But if the exchange of vocalisation and visual cues is sufficient, they'll stick to that while still being very close. So, one of the questions that Charrier and her colleagues had a few years ago was precisely how these males assess each other. Based on the acoustic displays, do they associate traits in their rivals' voices with size or dominance status or do they recognise each particular individual?

Who is who on the beach

In the animal world, physical features of an individual sometimes encode information about other attributes. In terms of acoustic displays, for example, the frequency of calls in frogs and toads is an indicator of body size, and male baboons give a two-syllable call (the memorable wahoo) that is correlated with age and social rank.

Given the importance of vocalisation in elephant seal males, the research team wondered whether qualities of the voice could be associated with physical details or social status. They recorded the vocalisation of different males, calculated size and age using photos with a calibrated scale and measured the social rank by observing different social interactions. "We basically scored the loser and the winner of each vocal interaction and, based on this, identified a particular individual as a high-ranking or as a subordinate male," explains Charrier.

They found a correlation between certain vocal features and body size (e.g. larger males emit lower frequency calls) but no acoustic parameters linked with dominance or indication that body size correlates with social rank. Nevertheless, when the scientists performed playback experiments – previously recorded calls now played through speakers close to the males tested – they found that vocal features were not really relevant for them to make a decision on fighting or retreating. While beta males go away when they hear a familiar dominant male and attack if a call from a subordinate male is broadcasted, they don't show this pronounced response when they are exposed to calls from unfamiliar males (e.g. recorded from a distant colony) (*R Soc Open Sci*, 2(8):150228). Previous social knowledge seems to be essential, "They need to really know each other individually. We showed that these guys know who is who on the beach," confirms Charrier.

Leaving or fighting: rhythm and timbre matter

Those results led to the question of how they recognise each other. Acoustic analyses on the calls showed that each individual has its own consistent vocal signature: a particular rhythm, the pulse rate of the call, and timbre, the feature that differentiates a high-pitched from a low-pitched voice. So, what happens if one modifies these properties?

Charrier and her team altered calls from dominant rivals and tested them on the beta males familiar with them, expecting to observe the retreat behaviour, if the call was still recognised as coming from a threatening neighbour. Using specialised software, they modified first the rhythm, by changing the number of 'claps' per second, and then independently the timbre, by re-scaling the spectral parameters. The researchers broadcasted both types of modified calls and evaluated the behavioural response of the tested males: would they respond to their dominant rivals' natural calls when they are slightly modified?

No. They barely reacted to them and in some cases even ignored them: the subordinate males showed to be sensitive to these changes. The alteration of rhythm and timbre also modified the response, suggesting that these two characteristics are required for individual vocal recognition (*Curr Biol*, 27(15): 2352-6).

Only wild mammal known "to feel the beat"

This ability to recognise and memorise rhythm has rarely been observed in other non-human mammals. The only other mammalian species that has shown the ability to recognise tempo without training is the bonobo: an individual studied in a zoo could spontaneously match and synchronise up their drum strikes, to a certain degree, with a human drummer. But the work of Charrier and her colleagues is the first to show the relevance of tempo in a wild mammalian species for a specific biological purpose. "Elephant seals are very sensitive to this pulse rate and that's new for mammals, given what we know so far," she says.

The team is also currently doing some work on elephant seal sub-adult males (the young peripheral ones) to better understand their behaviour during the breeding season and investigate how they assess the other males. They have already performed some playback experiments that are currently under analysis. "We would like to know if they show the same strategy and see whether, for example, they can estimate each other's age from the vocalisation."

This year, the team will also start a project on mother-pup recognition in this same species. We will stay tuned, to learn whether the fascinating sense of rhythm in the northern elephant seals is also present outside of the fierce mating competition.

ALEJANDRA MANJARREZ