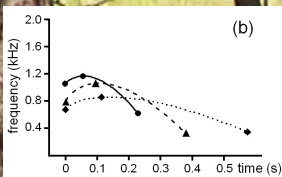
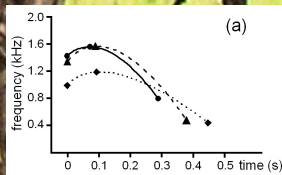


Acoustic variation in Siberian wapiti *Cervus elaphus sibiricus*: effects of sex and age

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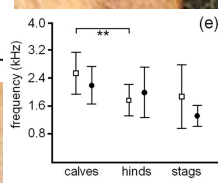
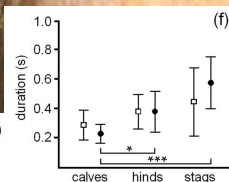
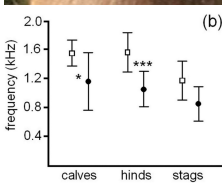
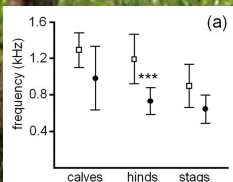
- Red deer *Cervus elaphus* is the **widespread species**, originated in Middle Asia and then slowly spread to Asia and further to Northern America, and to Europe
- Red deer forms many subspecies displaying a **strong divergence of vocal characteristics**
- The call **fundamental frequency (f0)** is the **main demarcating acoustic trait** between European and Asian/American branches of *red deer*. European subspecies produce calls with low maximum f0 (52-270 Hz), the Asian and American subspecies produce calls with very high maximum f0 (660-2080 Hz).
- In stags and hinds, f0 values are closer within than between subspecies. Red deer **adult males** use **rutting calls** for deterring rival males and for attracting receptive females, and **adult females** and **calves** use **contact calls** for mother-offspring communication.
- Studying vocal divergence across subspecies and sex and age-classes of *Cervus elaphus* might help in tracing the evolution of vocal communication in this species.

Fundamental frequency (f0) contours of Siberian wapiti contact calls.



(a) Oral contact calls. (b) Nasal contact calls. Solid lines with circles indicate calves, dashed lines with triangles indicate hinds; dotted lines with rhombs indicate stags. The circles, triangles and rhombs label positions of call start, maximum and end fundamental frequencies.

Acoustic variables of oral and nasal contact calls of Siberian wapiti calves, hinds and stags.



Central points (white = oral calls; black = nasal calls) indicate mean values; whiskers show \pm SD: (a) the mean fundamental frequency; (b) the maximum fundamental frequency; (e) the frequency of maximum amplitude; (f) call duration. Tukey post-hoc results significant differences: * - $p < 0.05$; ** - $p < 0.01$; *** - $p < 0.001$; stars with brackets indicate significant differences between sex and age-classes; stars without brackets indicate significant differences between oral and nasal contact calls.

Collecting data

- 3 zoos (Berlin, Novosibirsk, St. Petersburg)
- 2 farms (Kazakhstan, Kostroma)
- 15 calves, 36 hinds and 12 stags

Recording calls

- Recorder Marantz PMD-660 with a AKG-C1000S microphone or a Sennheiser K6- 170 ME66



Acoustic analysis

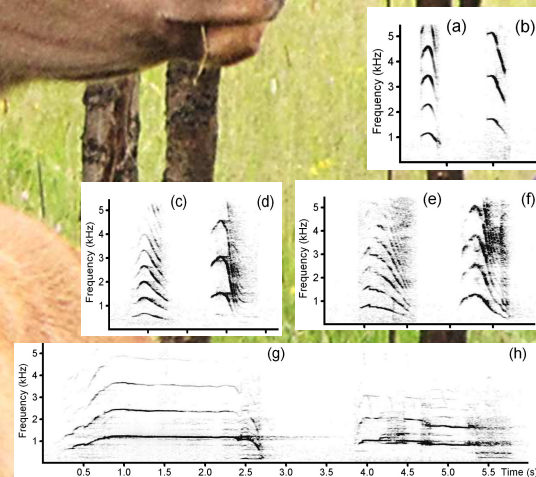
- Avisoft SAS Lab Pro, Praat
- The same set of 13 acoustic variables for each call
- 2 temporal variables, 6 variables of fundamental frequency (f0) and 5 power variables

Statistical analysis

- STATISTICA, v. 6.0
- ANOVA



Spectrogram of Siberian wapiti calls.



(a) Calf nasal contact call. (b) Calf oral contact call. (c) Hind nasal contact call. (d) Hind oral contact call. (e) Stag nasal contact call. (f) Stag oral contact call. (g) Stag bugle rutting call. (h) Hind bugle call.

Conclusion:

- This is the first study reporting the emission of contact calls in red deer stags and the second study (after Feighny et al. 2006) reporting the emission of bugles by red deer hinds.
- Siberian wapiti calf contact calls (both oral and nasal) have the same maximum fundamental frequency as hinds
- As compared to other subspecies of *Cervus elaphus*, contact calls of calves and hinds as well as bugles of stags and hinds in Siberian wapiti were closer in fundamental frequency to American subspecies than to European subspecies, being substantially higher than in any European subspecies of *Cervus elaphus* and higher than in an Asian subspecies *C. e. xanthopygus*.