



RESEARCH NOTE

The sound of a snail: two cases of acoustic defence in gastropods

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Sound production has evolved independently in many phyla over time (Senter, 2008). Many animals produce sounds for communication, either with congeners or in reaction to predators (for examples of the latter in invertebrates see Bura, Fleming & Yack, 2009; Olofsson, Jakobsson & Wiklund, 2012), but Vermeij (2010) noted that deliberate production of acoustic signals is entirely unknown in the phylum Mollusca. However, Braun (1887) was the first to report briefly about the sound-producing snail *Cantareus apertus* (Born, 1778). He wrote “Es ist allgemein bekannt [sic], dass namentlich die grösseren Helices dadurch erzeugen, dass die in Lufthöhle angesammelte Luft aus dem Athemloch herausgestossen wird; gewöhnlich wird eine geringe Menge Schleim in kleine Blasen dabei aufgetrieben, deren Platzen das Geräusch vermehrt” [It is well known that especially the larger helices generate noise as the air in the pulmonary cavity is expelled through the pneumostome; usually a small amount of mucus is extruded and the bursting of small bubbles increases the sound]. This species was also mentioned by Caziot (1914), together with references to sounds produced during locomotion by other helicids and some limacid slugs (Vlès, 1908, 1909; Jousseau, 1909). However, *C. apertus* makes the noise when resting, its shell rocking back and forth (see video by Wenger, 2014); the sounds produced by this species are made in the context of antipredator defence behaviour, after the shell has been touched suddenly. In terrestrial gastropods retraction into the shell is an important defence mechanism, usually accomplished while the aperture is facing down on the locomotion surface. In addition to this passive mode of defence, secretions from the skin and mucus glands can deter predatory attacks, due to the distasteful and deterrent compounds they may contain (reviewed for marine molluscs by Derby, 2007; see Pakarinen, 1994, and Mair & Port, 2002, for terrestrial examples). The topic of sound production in (land) snails seems to have been largely neglected since the paper by Caziot (1914), except for the mention by Fechter & Falkner (1990: 244–245) of the common name ‘Grunzschnecke’ (grunting snail) for *C. apertus* and the remark by Vermeij (2010).

Recently, G. Woehl and a colleague, while collecting amphibians at night in Brazil, recorded the sound of a snail by serendipity. The snail was found in leaf litter in *Araucaria* forest at Itaiópolis, Santa Catarina State, on 16 November 2013, where it had been attacked by a predator (presumably a mammal) shortly before. When they found the snail, it also secreted an orange mucus, possibly as a defensive mechanism. According to Woehl (personal communication) “the snail was moving and foaming”. In other words, it was alternately retracting after the

shell was touched and then emerging (cf. movements shown by Wenger, 2014) and producing mucus. Moreover, the snail repeatedly emitted a sound when touched, of which one instance was recorded with a Sony voice recorder ICD-PX312. The original file was analysed using the audio software OcenAudio v. 2 (OcenAudio Team); the extracted file of the snail sound is available in MP3-format in the Supplementary Material. The analysis revealed that the sound lasted 241 ms and consisted of two different pulses of, respectively, 52 and 58 ms, with a 131 ms interval between (Fig. 1). In the spectral view it can be seen that both pulses have a regular harmonic structure, with emphasis on the range 1500–10,000 Hz (Fig. 2). Further analysis suggests a fundamental at 1650 Hz and three harmonics at, respectively, 3300, 4970 and 6630 Hz in the first pulse (Fig. 3); the fundamental is a relatively high tone, comparable with G₆[#]. In the second pulse these tones are similar, although slightly higher (ca. 50–100 Hz). It should be noted that the tones are not even; the first pulse is slightly curved and in the second one there is a very brief compression after which the tones fade away (Fig. 2); in both pulses the minimum–maximum difference in the fundamental is ca. 400 Hz. Whether this composite sound was produced by means of compression of the pulmonary cavity or by other means remains unknown. A spectral analysis gives no clues about the underlying mechanical origin of the sound signal (Elemans, Muller & Heeck, 2008). It can be assumed, however, that the sound has to be interpreted either as a stress signal or a signal to a predator.

Also of interest is the question of the taxonomic identity of the snail. Unfortunately, the snail was only photographed (Fig. 4) and not collected. Given the size (ca. 50 mm) and shape, there are only a few candidates in the known Brazilian malacofauna; these belong to the families Megalobulimidae and Amphibulimidae (both Stylommatophora). According to I. Agudo (personal communication) this is none of the local *Megalobulimus* species; he suggested instead a *Plekocheilus* species. This genus, belonging to the Amphibulimidae (*sensu* Breure & Romero, 2012), is represented by six species according to Simone (2006: 149–150). In addition the species classified by this author (Simone, 2006: 147) as *Dryptus rhodocheilus* (Reeve, 1848) belongs to *Plekocheilus* (Breure, 1979: 32; Breure & Ablett, 2011: 34). After carefully inspecting the photographs (Fig. 4), I tentatively identify the snail as *Plekocheilus* aff. *rhodocheilus*. This species was described from ‘Brazil’, without further specified location and has never been recorded since. The lectotype specimen is in the Natural History Museum, London (Breure & Ablett, 2011: fig. 21E–H). It may be noted that the type shell is damaged on the last whorl and at

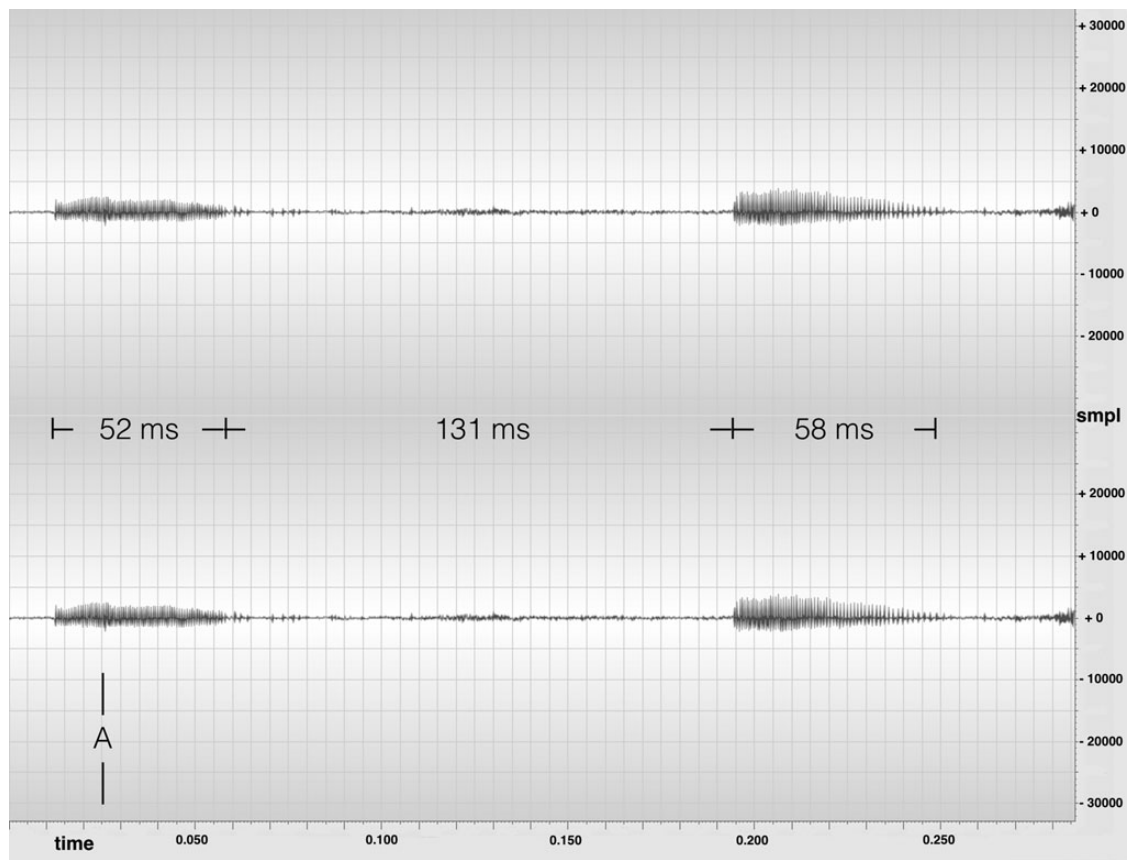


Figure 1. Waveform view of the recorded snail sound, showing two pulses of 52 and 58 ms, with an interval of 131 ms. Abbreviation: A, cross section shown in Figure 3.

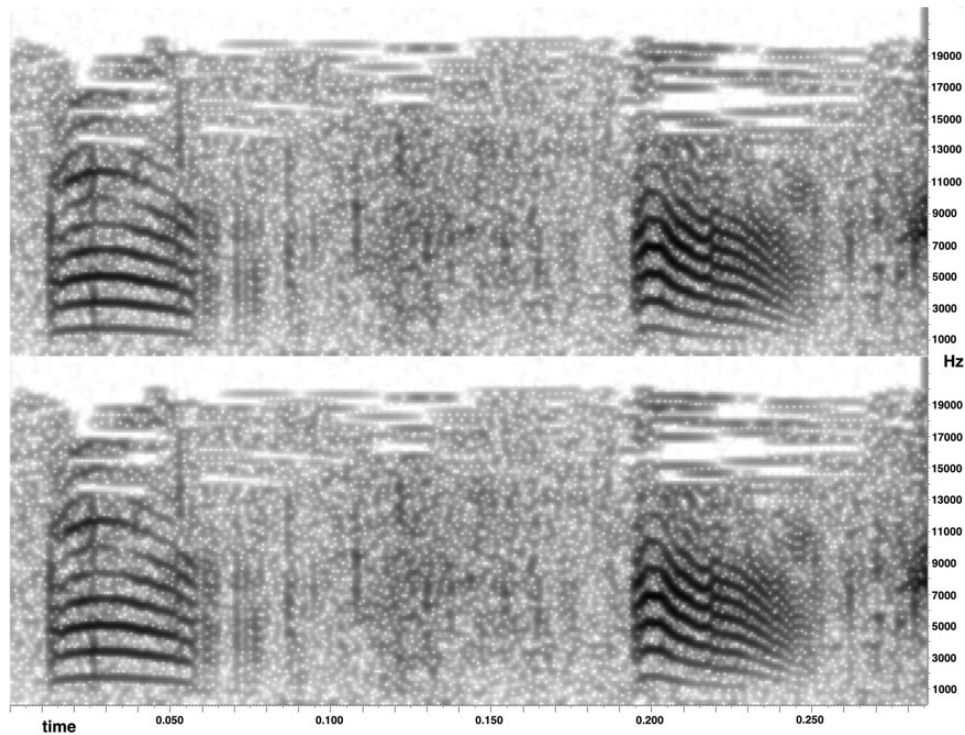


Figure 2. Spectral view of the recorded snail sound, showing layered structure of the pulses (X = time; Y = Hz).

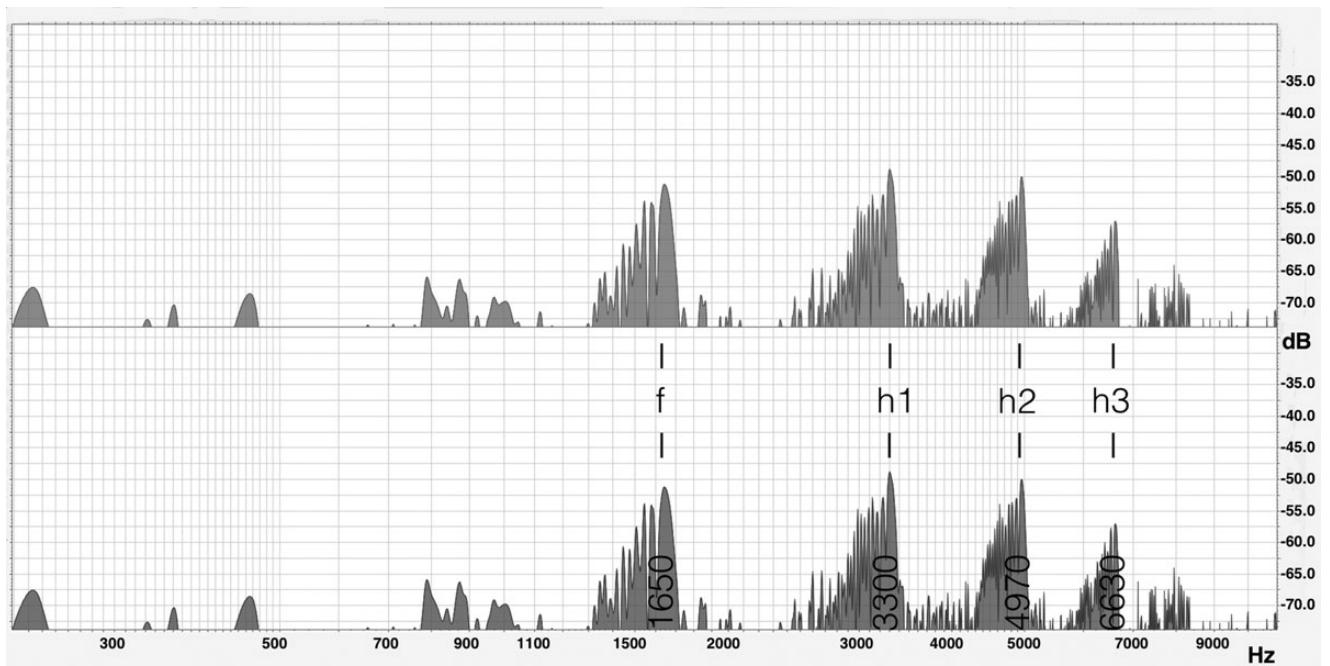


Figure 3. Fourier analysis (FFT) in a Hanning window sampled with 2048 bins on a logarithmic scale, showing the spectral range ($X = \text{Hz}$; $Y = \text{dB}$) at time 0.025 s in the studied recording (Fig. 1, A). Abbreviations: f, fundamental; h1, first harmonic; h2, second harmonic; h3, third harmonic.



Figure 4. A–D. Different views of *Plekocheilus* aff. *rhodocheilus* (Reeve, 1848), Itaiópolis, Brazil (photographs courtesy G. Woehl). Scale bar = 10 mm.

the apertural lip; incidentally, this could have been caused by predation, although these fractures were not documented in the original register. If the snail from Itaiópolis was indeed *P. rhodochelilus*, the species would appear to be a rare, endemic relict occurring in southern Brazil, possibly explaining why it has not been refound since its description. Nevertheless, these photographs are not conclusive evidence and anatomical data, preferably from a full-grown specimen, and molecular research are needed to establish the identity and affinities of this taxon.

The question remains whether the sounds produced by both *Cantareus* and *Plekocheilus* can be interpreted as *deliberately* produced. Both the record by Wenger (2014) and that reported herein are of sounds made during retraction into the shell, and could merely be a side-effect of this deliberate action (i.e. release of air through the pneumostome, as mentioned by Braun, 1887). Interestingly, the frequency of sounds may vary: in *Plekocheilus* two sounds were made after each touching of the shell; in *C. apertus* three sounds were recorded by Wenger (2014), but Braun (1887) wrote “aber es geschah nicht einmal, sondern achtmal hintereinander (...) Ein zweites Exemplar war nicht so empfindlich, sondern kroch bald munter umher” [it did not happen once, but eight times in a row... A second snail was not as sensitive and soon resumed crawling]. This suggests individual variation. The recording by Wenger (2014) is not of sufficient quality to permit a full analysis; however, a tentative analysis suggests that the structure of the sound differs from that of *Plekocheilus*. Both sounds could originate from the soft parts of the snail, contrary to Vermeij's (2010) suggestion that strigilation by hard parts (i.e. shell and operculum) might be envisaged. In both instances the sounds were recorded by serendipity and it could be that other gastropods emit sounds under similar circumstances. Malacologists should be aware of this possibility and examine other species accordingly, either in the field or under laboratory conditions. The biological significance and evolutionary origin of sound production in terrestrial gastropods are avenues for further exploration, once more instances have been found by careful observations.

SUPPLEMENTARY MATERIAL

Supplementary material is available at *Journal of Molluscan Studies* online.

ACKNOWLEDGEMENTS

Many thanks are due to G. Woehl Jr. (Instituto Rã-bugio, Vila Bependi, SC, Brazil) for supplying the raw data on which this note is based; I. Agudo (Florianópolis, SC, Brazil) initially sent me the photographs for identification. H.J.A. Breure is thankfully acknowledged for making useful suggestions during the audio analysis. G.J. Vermeij pointed out the exceptional nature of this case and stimulated the writing of this paper. G.J. Vermeij and H. Reise reviewed the paper and made valuable suggestions for improvement. Lastly, B. Hausdorf and G. Falkner are thanked for their information on some of the literature and for pointing out the case of *Cantareus apertus*.

REFERENCES

- BRAUN, M. 1887. Ueber eine Art Stimme bei *Helix aperta* Born. *Nachrichtsblatt der Deutschen Malakozoologischen Gesellschaft*, **19**: 125.
- BREURE, A.S.H. 1979. Systematics, phylogeny and zoogeography of Bulimulinae (Mollusca). *Zoologische Verhandlungen Leiden*, **168**: 1–215.
- BREURE, A.S.H. & ABLETT, J.D. 2011. Annotated type catalogue of the Amphibulimidae (Mollusca, Gastropoda, Orthalicoidae) in the Natural History Museum, London. *ZooKeys*, **138**: 1–52.
- BREURE, A.S.H. & ROMERO, P.E. 2012. Support and surprises: molecular phylogeny of the land snail superfamily Orthalicoidae using a three-gene locus analysis with a divergence time analysis and ancestral area reconstruction (Gastropoda: Stylommatophora). *Archiv für Molluskenkunde*, **141**: 1–20.
- BURA, L., FLEMING, A.J. & YACK, J.E. 2009. What's the buzz? Ultrasonic and sonic warning signals in caterpillars of the great peacock moth (*Saturnia pyri*). *Naturwissenschaften*, **96**: 713–718.
- CAZIOT, E. 1914. Le chant des Mollusques et principalement de l'escargot. *Annales de la Société Linnéenne de Lyon*, N. S., **60**: 39–44.
- DERBY, C.D. 2007. Escape by inking and secreting: marine molluscs avoid predators through a rich array of chemicals and mechanisms. *Biological Bulletin*, **213**: 274–289.
- ELEMANS, C., MULLER, M. & HEECK, K. 2008. Spectrogram analysis of mechanical events in sound production of animals. *Bioacoustics*, **18**: 183–212.
- FECHTER, R. & FALKNER, G. 1990. *Weichtiere. Europäische Meeres- und Binnenmollusken*. Mosaik Verlag (Reihe Steinbachs Naturführer), München.
- JOUSSEAUME, F. 1909. Bruit de clappement produit par des limaces. Différents modes de locomotion chez les mollusques pulmonés. *Bulletin de la Société Zoologique de France*, **34**: 108–115.
- MAIR, J. & PORT, G.R. 2002. The influence of mucus production by the slug, *Deroceras reticulatum*, on predation by *Pterostichus madidus* and *Nebria brevicollis* (Coleoptera: Carabidae). *Biocontrol Science and Technology*, **12**: 325–335.
- OLOFSSON, M., JAKOBSSON, S. & WIKLUND, C. 2012. Auditory defence in the peacock butterfly (*Inachis io*) against mice (*Apodemus flavicollis* and *A. sylvaticus*). *Behavioral Ecology and Sociobiology*, **66**: 209–215.
- PAKARINEN, E. 1994. The importance of mucus as a defence against carabid beetles by the slugs *Arion fasciatus* and *Deroceras reticulatum*. *Journal of Molluscan Studies*, **60**: 149–155.
- SENER, P. 2008. Voices of the past: a review of Paleozoic and Mesozoic animal sounds. *Historical Biology*, **20**: 255–287.
- SIMONE, L.R.L. 2006. *Land and freshwater molluscs of Brazil*. EGB/Fapesp, São Paulo.
- VERMEIJ, G.J. 2010. Sound reasons for silence: why do molluscs not communicate acoustically? *Biological Journal of the Linnean Society*, **100**: 485–493.
- VLÈS, F. 1908. Quelques observations sur les bruit très spéciale que producent parfois des *Helix*. *Bulletin de la Société Zoologique de France*, **33**: 145.
- VLÈS, F. 1909. Sur les bruit émis par des *Helix* pendant leur progression. *Bulletin de la Société Zoologique de France*, **34**: 251–254.
- WENGER, R. 2014. *Cantareus apertus*. Available at <https://www.youtube.com/watch?v=zXC0M-q3ie0> (accessed 23 August 2014).