Some vocalisations of the Grey Falcon *Falco hypoleucos*

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Sound-recordings of some calls of the Grey Falcon *Falco hypoleucos* (adult cackle calls, juvenile begging whines) are described and presented as sound spectrograms, and compared with some equivalent calls of the Peregrine Falcon *F. peregrinus* (adult female cackle, juvenile begging whine, probable juvenile cackle). The Grey Falcon cackle calls are similar to those of the Peregrine, though variously softer and clearer, more 'squeaky' and/or more guttural (the Peregrine cackles being more strident and whining). Grey Falcon juvenile begging calls are more falsetto than those of the Peregrine. Fundamental frequencies differ slightly (Grey Falcon adult female cackle calls at ~700 Hz, Peregrine at ~1 kHz for juvenile begging calls, ~2 kHz for adult female cackle calls). The vocal data are consistent with the phylogenetic position of the Grey Falcon as basal to the Peregrine and 'great falcon' groups.

INTRODUCTION

The endemic Grey Falcon *Falco hypoleucos*, of the Australian arid inland, is a rare and elusive species that is often misidentified. The sound-recordings made by Baylis and van Gessel (2011) are the only published recordings of the species' calls, a prior claimed recording having been referred to the Brown Falcon *F. berigora* (see Schoenjahn 2010). However, sound-recordings were made during the Grey Falcon study by Falkenberg (2011), but could not be retrieved for inclusion in that paper (I. Falkenberg pers. comm.). Conversely, the Peregrine Falcon *F. peregrinus* is found worldwide (with an endemic Australian subspecies), and its calls are better known (e.g. Marchant and Higgins 1993; Turner *et al.* 1993).

The vocalisations of the Grey Falcon were described by Watson (2011), who noted that further study is required, incorporating contexts, sound-recordings and comparison with other falcons. Concurrently, Baylis and van Gessel (2011) briefly described the vocalisations of two Grey Falcon pairs and their dependent fledglings (broods of one and three young), with spectrograms, though not categorising the call types according to standard terminology (e.g. as defined by Carlier 1995 and Leonardi *et al.* 2013).

In the absence of sound spectrograms of Grey Falcon calls in Marchant and Higgins (1993) and later scientific studies on this species, Figures 1–4 of Baylis and van Gessel (2011) are reproduced here and the vocalisations categorised following Carlier (1995). Falcon vocalisations are evidently innate (Cade 1982; Jurisevic 1998), and there is no suggestion of geographical variation within Australia in the calls of such mobile species (Marchant and Higgins 1993), so the results presented here may be applicable continent-wide. Interspecific comparisons of calls may also provide

taxonomic insights, as the affinities of the Grey Falcon have been obscure, though suspected to lie with the Peregrine and/or 'great' falcons (Black Falcon *F. subniger* and its overseas relatives; e.g. Debus 2011).

METHODS

Sound spectrograms are graphical representations of the structure, pitch and tempo of bird calls, and 'can be read like a musical score from left to right; the vertical axis shows frequency (pitch) and the horizontal axis shows time elapsed' (Powys 2010). The minimum or fundamental frequency is the lowest value (trace) in the spectrogram for a given call, and the dominant frequency of a given call is the frequency band that contains the greatest acoustic energy (see Jurisevic 1998).

Recordings of Grey Falcon calls were made at two nests in the Northern Territory by FVG on 30 October and 2 November 2011, and at one of these (with three fledglings) by TB on 15 November. FVG used several open Sennheiser K6 modular ME66 microphones and parabolic dish (50-cm diameter fitted with an ME64 microphone) with a digital Sound Devices 702 recorder, and TB used a pair of coincident MKH40 microphones on a long lead to a Nagra BB recorder (Baylis and van Gessel 2011). The recordings by FVG were made using a sampling rate of 96 kHz at 24 bits as WAV files. The recordings made by TB were at 48 kHz, 16-bit WAV files (no compression). To generate the spectrograms, all recordings were edited and down-sampled to 44.1 kHz at 16 bits (i.e. CD quality) for use with Raven Lite 1.0. The fast fourier transform (FFT) was set at 512, otherwise settings were Raven Lite 1.0 default settings (e.g. window type is Hann, setting unstated for dB

depth). The recordings will be made available to *bona fide* researchers, but not publicly (e.g. through Sound Cloud), to reduce the risk of over-use and misuse of call-playback on a rare, threatened species.

Further sound-recordings, made by FVG, of an adult female Grey Falcon at one of the above nests (2 November 2011) are included here. The equipment, settings and spectrogram generation were as above. These recordings were made at a distance of approximately 30 metres, in good weather conditions though breezy.

Sample calls of a Peregrine Falcon *Falco peregrinus* (from Tunnel Creek, WA) are included for comparison. Recordings were made by TB with a Nagra BB at 48 kHz, 16 bits, with an Ian Brady microphone in an Atherstone parabolic reflector, and treated as above for generating spectrograms using Raven Lite 1.0. Sample calls of Peregrine Falcons recorded by FVG are also included (adult female: Mootwingee National Park, western NSW, 19 September 1988; juvenile begging: Woy Woy, NSW central coast, 24 January 2004). Spectrograms were generated as above for FVG's other recordings.

In reprocessing the sound-recordings (by TB) for presentation of spectrograms herein (Figures 1–10) at the same scale (standardised to 3.5 sec. in length), all spectrograms were made using Raven Pro 1.4, FFT 1024, Hann window, overlap 50%, then in Photoshop colour information was discarded. No low-cut filter was used on the sound-recordings, but for producing the spectrograms a filter was used to delete the very low frequencies made by traffic noise and wind (i.e. environmental noise). The Grey Falcon spectrograms are from typical samples of multiple

recordings of multiple individuals (see above), which we regard as representative of the respective call types of that species. Similarly, the Peregrine spectrograms are representative examples of some common call types. As such, the species' calls and their comparisons are likely to be within, and applicable to, the range of individual variation (based on our collective field experience of these species).

RESULTS AND DISCUSSION

Spectrograms of the calls of Grey Falcon adults and fledglings (Figure 1–4), when compared with a CD of those call recordings (produced by the Australian Wildlife Sound Recording Group), can be interpreted as follows. Figure 1, 'Greeting call', is a fast cackle by the adult male, softer and clearer than the typical cackle of the Peregrine Falcon. Figure 2, 'Whining call', is a juvenile begging call (possibly a male). Figure 3, 'Whining call (variation)' is another juvenile begging call (possibly a female). Figure 4, 'Cackling call', is a slower (than Figure 1), 'complaining' cackle, not staccato.

Calls of an adult female Grey Falcon are (Figure 5) a slow, 'squeaky' cackle, and (Figure 6) a slow cackle as approaching the nest, less squeaky than the track for Figure 5. An additional call sequence of this bird, not shown here, sounds essentially the same as the track for Figure 5, though slowing down towards the end of the sequence.

Calls of a Peregrine Falcon (Figures 7, 8) are respectively a low-intensity cackle and a slightly faster (but 'mild') cackle, uttered sequentially by the same

individual (unknown age/sex) perched on and just before leaving a cliff ledge (Figures 9 and 10, respectively). Given the date (6 November 2011), this bird may have been a dependent juvenile. Its calls are similar in tonal quality to the slow cackle and faster begging whine of the Grey Falcon (Figures 3, 4), but it is not certain that directly equivalent calls are represented.

A cackle of moderate intensity and speed by an adult female Peregrine Falcon (Figure 9) is of similar tempo to the adult female Grey Falcon's cackle (Figure 5, 6), though more strident and whining in tone. A Peregrine juvenile begging call (Figure 10) is similar to the equivalent Grey Falcon call (e.g. Figure 2), but the latter call is more falsetto.

In some of these recorded calls or phrases (notably the begging whines and the slow cackle, Figures 2–4) of the Grey Falcon, the tonal quality is similar to equivalent calls of the Peregrine Falcon, though in some cases (Figures 5, 6) more guttural than the Peregrine's call (Figure 9). The fundamental frequency of the Grey Falcon calls is about 700 Hz (Figures 5, 6), whereas the fundamental frequency of the Peregrine calls is about 1 kHz for the begging juvenile (Figure 10) and 1–2 kHz for the adult female cackle (Figure 9). A further difference in the adult female cackles of each species is that the Grey Falcon individual syllables (Figure 4) are downslurred, whereas those of the Peregrine Falcon (Figure 9) are upslurred.

At the scale of printing of the spectrograms in Marchant and Higgins (1993) and Jurisevic (1998), it is not possible to directly compare the metrics of Peregrine Falcon calls with those of the Grey Falcon spectrograms herein, nor would it be

certain that equivalent calls were being compared. All that can be said is that certain cackle calls of the Grey Falcon appear to be similar in characteristics (dominant frequencies, pulse rates) to cackle calls of the Peregrine Falcon, and of the Black Falcon (see Jurisevic 1998). Spectrographic metrics of the calls of Australian falcons require further study and comparison, of specific call types (e.g. cackle, creaking call, wail) in specific contexts across species. Also, methods and settings need to be standardised so that spectrograms can be compared between studies (see Robertson 2013). Spectrographic call metrics, for comparison between species, can often depend on the distance and atmospheric conditions when recording the birds in the field.

This study on vocalisations is consistent with the recent finding, based on DNA, that the Grey Falcon clusters basally to the Peregrine and 'great' falcons in the *Falco* genetic tree (Wink *et al.*in press). It remains to record and analyse its other call types (e.g. as described by Watson 2011), and to conduct a similar spectrographic study on the Black Falcon, for which a behavioural study (Charley *et al.* 2014) has provided more detailed (verbal/phonetic) call descriptions than were hitherto available for that species.

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Figures 1–6. *Spectrograms of calls of Grey Falcon: (1) adult male fast greeting cackle; (2, 3) juvenile food-begging whine; (4) adult slower cackle; (5) adult female squeaky cackle; (6) adult female cackle as approaching nest. Northern Territory, October–November 2011; spectrograms prepared using Raven Lite 1.0.*

Figures 7–10. *Spectrograms of calls of Peregrine Falcon: (7, 8) two sequential sequences (unknown age/sex, possibly juvenile), Tunnel Creek National Park, WA, November 2011; (9) adult female cackle, Mootwingee National Park, NSW, September 1988; (10) juvenile begging whine, Woy Woy, NSW, January 2004. Spectrograms prepared using Raven Lite 1.0.*