Kurze Mitteilungen

Sickle-shaped primaries and tail feathers involved in sound production in Siberian Grouse *Falcipennis falcipennis* Hartlaub 1855

Siegfried Klaus, Alexander V. Andreev, Michael A. Schroeder and Christoph Unger

Sichelförmige Schwung- und Schwanzfedern – beteiligt an der Lauterzeugung beim Sichelhuhn *Falcipennis falcipennis* Hartlaub 1855

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Siegfried Klaus ✉, Lindenhöhe 5, 07749 Jena, Germany
E-Mail: siegi.klaus@gmx.de

Alexander V. Andreev, Institute of Biological Problems of the North, Portovaya 18, Magadan 685000, Russia
E-Mail: alexandrea@mail.ru

Michael A. Schroeder, Washington Dept. of Fish and Wildlife, P.O. Box 1077, Bridgeport WA98813, USA
E-Mail: grouse@homenetnw.net

Christoph Unger, Obere Gasse 23, 98646 Hildburghausen
E-Mail: corvus_hibu@freenet.de

Vocal and non-vocal sounds are involved in the complex display behaviour of birds in general, and grouse in particular (Hjorth 1970). This is true also in the Siberian Grouse, a rare endemic bird of the Russian Far East (Potapov 1985, Andreev and Hafner 1998, Hafner and Andreev 1998, Storch 2000, Andreev et al. 2001). The species is listed in the national Red Data Books of China (Probably Extinct) and Russia, according to IUCN at lower risk (Near Threatened).

The former English name „Sharp-winged Grouse" comes from the unique sickle shape of the outermost four or five primaries; the most pronounced is no. 10, followed by nos. 9, 8 and to a lesser degree 7 and 6 (Fig. 63 in Potapov 1985 , Fig. 1). The American sister species Spruce *Falcipennis canadensis* and Franklin's Grouse *F. franklinii* differ in this respect. Both have normally-shaped primaries, with the exception that primaries 9 and 10 are relatively pointed in yearling birds. Although we consider all three species to be members of the same genus, *Falcipennis*, their phylogeny remains unsettled (Persons et al. 2016). The purpose of this paper is to discuss the function of the sickle-shaped primaries in Siberian Grouse.

All three species inhabit very similar habitats in dense conifer forests, and produce non-vocal sounds during drumming flights or territorial flights. All are able to perform short vertical flights from ground to tree or vice-versa in territorial behaviour. The Siberian Grouse has the smallest wing area relative to its body size of all the grouse (Potapov 1985) and is a poor disperser, like Hazel Grouse *Tetrastes (Bonasa) bonasia* (Hafner and Andreev 1998, Swenson 1991). The vocal song of

Fig. 1. In this male, equipped with a necklace transmitter, the sickle shape of the pointed primaries is visible. – *Besendertes männliches Sichelhuhn. Die sichelförmigen Handschwingen sind gut zu erkennen.*
Photo: S. Klaus, May 1994

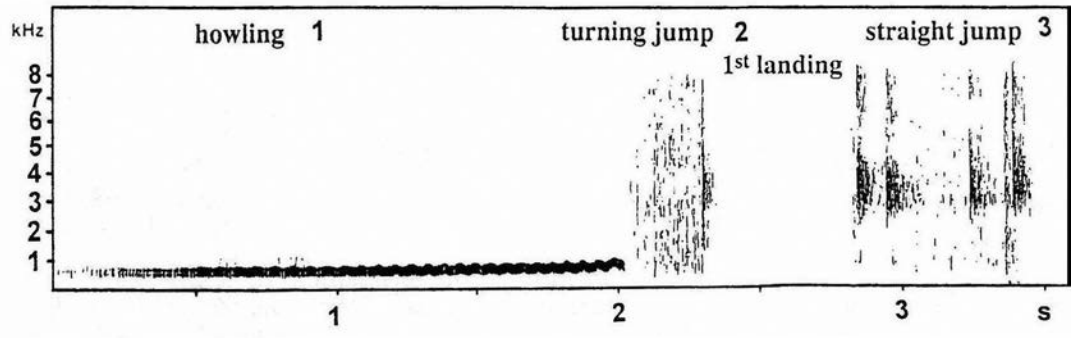

Fig. 2. Sonogram: the display song starts with the howling or hooting sound, followed by 2 jumps. The 1st click is at the end of the turning jump, two double-clicks follow during the straight jump, indicated as long vertical lines. Duration of the whole performance 3.5 s. – *Sonagramm: der Reviergesang beginnt mit einem Heulton, gefolgt von zwei Sprüngen. Der erste Klicklaut erfolgt am Ende des Drehsprungs (Abb. 3), zwei Doppelklicks folgen während des Vorwärtssprungs (Abb. 4). Gesamtdauer: 3,5 Sekunden.*
(Orig. H.-H. Bergmann)

male Siberian Grouse starts with a rising hooting or howling („like the wind in a chimney") sequence, about 2 s long **(**Fig. 2**),** uttered simultaneously with the non-vocal vibration of the wings, followed by the 2-part flutter-jump. The flutter-jump is unique in the species and is its main performance display; it starts with a 180° turning jump which is followed by a straight jump (Pukinskij and Nikanorov 1974, Klaus and Andreev 1991, Möllers et al. 1996, Möllers 1998, Andreev et al. 2001). The turning jump **(**Fig. 3**)** is followed by a single „click" and two double-clicks are heard during the straight jump **(**Fig. 4**)**. A single click is also heard when the male performs a flutter-flight from a tree to the ground. This flutter-flight, but without the click, is also performed by male Spruce Grouse (Boag and Schroeder 1992).

Fig. 3. Turning jump of a male Siberian Grouse. – *Drehsprung des männlichen Sichelhuhns.*
Photo: C. Unger 19 May 2016

Hypothetical functions of the pointed primaries

1. The sharp turn in the first part of the 2-part flutter-jump (Fig. 3) within a tiny area (< 1m²) may be aided by the sickle form of the primaries reducing the small wing area. Only 4 wing-beats are needed to turn the male by 180° (Andreev et al. 2001). The second jump (8–10 wing-beats) may also benefit from these feathers. They definitely help in the turnabout jumps, though in other „turn-jumpers" like Dusky Grouse *Dendragapus obscurus* or Caucasian Grouse *Tetrao (Lyrurus) mlokosiewiczi* such pointed primaries are absent. In contrast to Siberian Grouse, both these species display in open habitat with enough space for

jumping! The female Siberian Grouse also has sharp primaries like the male, but has never been observed to perform display jumps, therefore additional functions also seem possible.

2. These pointed primaries may help in escape flights through the dense spruce canopy (Klaus et al. 1995). We observed this type of flight as a response to avian predators like Northern Goshawk *Accipiter gentilis*. In play-back experiments using the Siberian Grouse male's flutter-jump sounds, a nearby Siberian Grouse male also responded with high-speed-flights through very dense vegetation.

3. These pointed feathers produce species-specific flight sounds involved in intraspecific communication. In winter, when leaving snow burrows, the birds attentively listen for other birds. At dawn and dusk they can hear both conspecifics and Hazel Grouse, with whom they are closely sympatric. Flight sounds in the two species differ and may help the Siberian Grouse to gather in feeding and roosting flocks (Andreev and Hafner 2011). As in

Fig. 4. Straight jump; the reduced wing area created by the sickle-like primaries is obvious. – *Vorwärtssprung. Die geringe Tragfläche durch die sichelförmigen Handschwingen ist erkennbar.*
Photo: C. Unger, 19 May 2016

Fig. 5. Landing after 2nd jump. The alula is well visible. – *Landung nach dem 2. Sprung mit gut sichtbarer Alula.*
Photo: C. Unger, 19 May 2016

other „turn-jumpers“ (Caucasian Grouse, Dusky Grouse) the alula is clearly exposed during the jump display of Siberian Grouse (Fig. 5). Whether the alulae are also involved in signal production or signal modification remains to be clarified.

At present, we have found no arguments to differentiate between these hypothetical functions. Possibly both communication and mobility in the dense habitat are supported by the sickle-shaped primaries and reduced wing area.

The click and tail-swish sounds

The origin of the loud click sounds (which can be heard from a distance of 80–100 m in dense forest) has been an object of discussion. There are arguments for the vocal origin of clicks: they are not detected during regular flights. There is no way to produce such clicks with wings after landing. In addition, clicks are missing during other seasons or away from the display area.

In Franklin's Grouse, when performing the tree-to-ground territorial flight, both wings produce the wing-clap sound (Boag und Schroeder 1992), while the ground-to-tree territorial flight is referred to as a „flutter-flight“, while is relatively loud but generally includes no wing-claps. In Spruce Grouse, territorial flights from tree-to-ground and ground-to-tree are both referred to as “flutter-flights”, involving no wing-claps (Ellison 1971, Möllers 1998). Clicks are missing in the display of both sister species. Only the display „walking with tail-swishing“, producing gentle but characteristic rustling sounds, is a common feature of all three species (Boag und Schroeder 1992, Möllers et al. 1995). In contrast to the American sister species, the tail-flick, the climax of the tail-swish display, is missing in the Siberian species.

During its long-term isolation, the Siberian Grouse has evolved as an „Asian innovation“ with a unique display behaviour based on some morphological features like the pointed primaries and reduced wing size, resulting in acoustic diversification, specialisation and reinforcement of displays in the dense conifer habitat. Later in the evolutionary process, that innovation might have developed into the clicks of the capercaillies *Tetrao urogallus* and *T. urogalloides*.

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