

Aggressive interactions between males of Chinese Grouse *Tetrastes sewerzowi* in autumn at Lianhuashan natural reserve, Gansu, Central China

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Aggressive Wechselwirkungen zwischen Männchen des Chinahaselhuhns *Tetrastes sewerzowi* im Herbst (Lianhuashan-Reservat, Provinz Gansu, Zentralchina)

An 38 aggressiven Begegnungen zwischen Männchen des Chinahaselhuhns waren 77 Individuen beteiligt. Die mittlere Dauer betrug 19,7 min (Spanne 2 bis 77 min). Die meisten Revierstreitigkeiten erfolgten am Boden (n = 21, 55 %). In Bäumen (Weidenarten, Eberesche) wurden 17 (45 %) registriert. Meist begannen die Auseinandersetzungen in bevorzugten Nahrungsbäumen, die von zwei Rivalen besucht wurden. Die Männchen wechselten auch vom Boden auf Bäume und umgekehrt. In Tab. 1 wurde der jeweils dominierende Aufenthalt Boden bzw. Baum dargestellt. Die 38 Auseinandersetzungen entfielen auf 22 Orte, d. h. einige erfolgten wiederholt an gleichen Orten. In 11 Fällen waren Weibchen bei der Nahrungssuche anwesend. Zwei verschiedene Lautäußerungen begleiteten die Revierausinandersetzungen: die seltenere Triller-Strophe (n = 6, 16 %) und die Quiekstrophe (n = 32, 84 %). Während des Streits wurde der einmal gewählte Typ der Lautäußerung beibehalten. Die Häufigkeit aggressiver Begegnungen stieg allmählich im Verlauf des Septembers an und kulminierte Mitte Oktober. Bereits in der 3. Oktoberdekade nahmen die Kampfhandlungen stark ab und endeten mit Beginn der Wintergruppenbildung. Das zweiphasige Verteilungsmuster der „Kämpfe“ zeigte einen kleineren Gipfel gegen 7 Uhr und einen höheren am Nachmittag gegen 16 Uhr. Zwischen 9 und 14 Uhr waren Aggressionen sehr selten. Sonagramme der Triller- und der Quiekstrophe sowie des Warnlauts (Plittern) werden erläutert. Vergleiche zwischen Frühjahr und Herbst sowie zur Geschwisterart Haselhuhn werden angestellt.

Keywords: Chinese grouse, *Tetrastes sewerzowi*, *T. bonasia*, aggressive behaviour, Lianhuashan reserve

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Introduction

The Chinese grouse *Tetrastes sewerzowi* inhabits the coniferous forests mixed with willow (*Salix* spec.), the dominant food, and other deciduous trees in the high mountains of Gansu, Qinghai, Sichuan, Yunnan and Eastern Tibet. The territorial and mating behaviour of the Chinese grouse in spring has been described earlier (Klaus et al. 1996, Sun & Fang 1997, Scherzinger et al. 2003). Both hazel grouse *Tetrastes bonasia* and Chinese grouse defend territories in spring and autumn (Swenson 1991, Bergmann et al. 1996 for a review). The aggressive behaviour in autumn as a part of the territorial activity has been studied in October 2000, 2006 and 2013. The territorial behaviour during the mating time in spring was studied yearly (1995–2013) allowing comparison between spring and autumn. Results of observations in only one season (in October 2000) has been described earlier (Klaus et al. 2009a). From our telemetry studies (Sun et al. 2003), we have learned that both males and females establish territories in autumn and that both sexes enter flocks in winter (Sun & Fang 1997) similar to northern and eastern populations of hazel grouse (Swenson 1993, Swenson et al. 1995). Consequently, the territorial activities are interrupted while they lived in flocks. Studying a subpopulation of Chinese grouse partly colour-banded and equipped with transmitters, we describe

1. the aggressive behaviour in autumn,
2. differences between autumn and spring,
3. comparisons with hazel grouse.

Study area and methods

Study area. The study of Chinese grouse was conducted in the Lianhuashan Natural Reserve in Gansu Province, central China (34°56′–58′N, 103°44′–48′ E). The highest peak is 3,578 m a.s.l. About 30 % of the reserve (11,691 ha in total) is forested, but only 1,170 ha were mature coniferous forests growing on limestone-derived soils, mainly on northern slopes (Klaus et al. 2001, 2013). The tree canopy is dominated by *Abies fargesii*, *Picea asperata*, *P. purpurea*, *P. wilsonii*, three species of *Betula* and about 24 species of *Salix*. The optimal habitats of Chinese grouse are characterized by the close vicinity of coniferous forests with a shrub layer of different species (*Berberis*, *Lonicera*, *Rhododendron*, *Rosa*, *Viburnum*, *Crataegus*, *Spirea*, *Cotoneaster*, *Rubus* etc.) that provided cover, and

groups of deciduous trees, and shrubs (*Salix* spp., *Betula* spp., *Sorbus khoeniana*, *Hippophaea rhamnoides*) that provided food in winter. The dense ground cover of bamboo *Sinarundinaria nitida* disappeared after intensive flowering in 2007. The study area is described more thoroughly in Klaus et al. (1996, 2001, 2009a), Sun et al. (2003, 2006) and Wang et al. (2012).

Methods. Foraging and territorial activity of the grouse were observed during 12 field days in October 2000, 22 field days in October 2006 and 17 field days in October 2013, when territorial activity culminated. During September and October 2013 (L. Y.), the beginning and end of aggressive behaviour were determined. Entire-day observations were concentrated on foraging males and females and the territorial activities of males (flutter jumps, noisy drumming flights, encounters). The data were corrected to realize equal observation times during the light hours of the day and during the decads of September and October. Here only the behaviour involved in encounters between males is described, based on the analysis of our video and sound recordings. Times given are local times in Gansu province/China. In the description of grouse behaviour, we follow the terminology of Hjorth (1965).

Results

General features. In Table 1 some general features are summarized. In 38 aggressive encounters 77 males were involved. In one case 3 males were seen together. The duration of encounters varied in a wide range (2–77 min, mean 19.7 min). Most of the aggressions occurred on the ground ($n = 21$, 55 %) the remaining 45 % ($n = 17$) in trees, including willow and mountain ash. Aggressive males were more often recorded in willows ($n = 10$) than in mountain ash ($n = 7$). For a short time in autumn, mountain ash *Sorbus* berries are a clearly preferred food. Our study of tree species composition on 30 plots distributed over the study area has shown that 23 % of all tree species was willow, only 1 % was mountain ash (Klaus et al. 1996). In most cases, aggressions started in preferred food trees visited by two neighbours. Often, males moved to both tree species or moved from ground to trees and vice versa. In the table, only dominant presence (ground or tree) was shown. 38 aggressions were recorded at 22 sites, indicating that some neighbour males came together repeatedly at the

Tab. 1. General features of encounters in Chinese Grouse *Tetrastes sewerzowi*. – *Allgemeine Merkmale von aggressiven Begegnungen zwischen männlichen Chinahaselhühnern Tetrastes sewerzowi.*

Year	n	on ground	in <i>Sorbus</i>	in <i>Salix</i>	n males involved	mean n females present	duration (min)	sites	trill song	squeak song
2000	18	13	3	3	37	3	24	9	0	18
2006	7	4	1	2	14	2	17	4	3	4
2013	13	4	4	5	26	6	18	9	3	10
sum	38	21	7	10	77	11		22	6	32

same site along their territorial border. During n = 11 aggressions females were present also. They continued feeding and were not involved in aggressions. Sometimes alarm calls (Fig. 3 d) of both sexes were noticed. The trill phrase was uttered in 6 cases (16 %). More frequently the squeak phrase (n = 32, 84 %) was noticed. During the whole duration of an encounter the type of vocalization did not change.

Monthly and daily distribution. Fig. 1 shows the frequency distribution of encounters during

September and October. A pronounced peak is seen in the second decad of October. At the end of October flock formation starts, depending on weather conditions (snow cover) and fructification of sand buckthorn (where flocks prefer feeding in late autumn and winter), resulting in a strong decline of aggressions during the third decad of October.

The diurnal pattern of aggression behaviour is demonstrated in Fig. 2 with a smaller peak in the morning (at 7 a.m., local time) and a somewhat higher peak in the afternoon (around 4 p.m.).

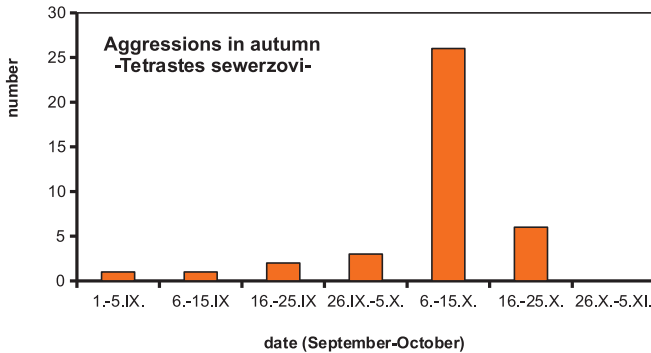


Fig. 1. Monthly distribution of encounters in Chinese grouse (n = 38) during September–October. – *Monatliches Verteilungsmuster aggressiver Begegnungen von Chinahaselhühner-Männchen (n = 38) im September und Oktober.*

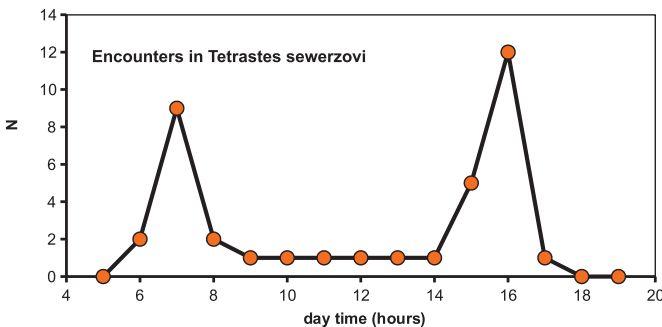


Fig. 2. Biphasic daily distribution of encounters (n = 38) in Chinese grouse in autumn. Day time corresponds to the local time in Gansu province. – *Zweigipfliges Verteilungsmuster der Revierauseinandersetzungen im Tagesverlauf. Uhrzeiten entsprechen der Ortszeit in Gansu.*

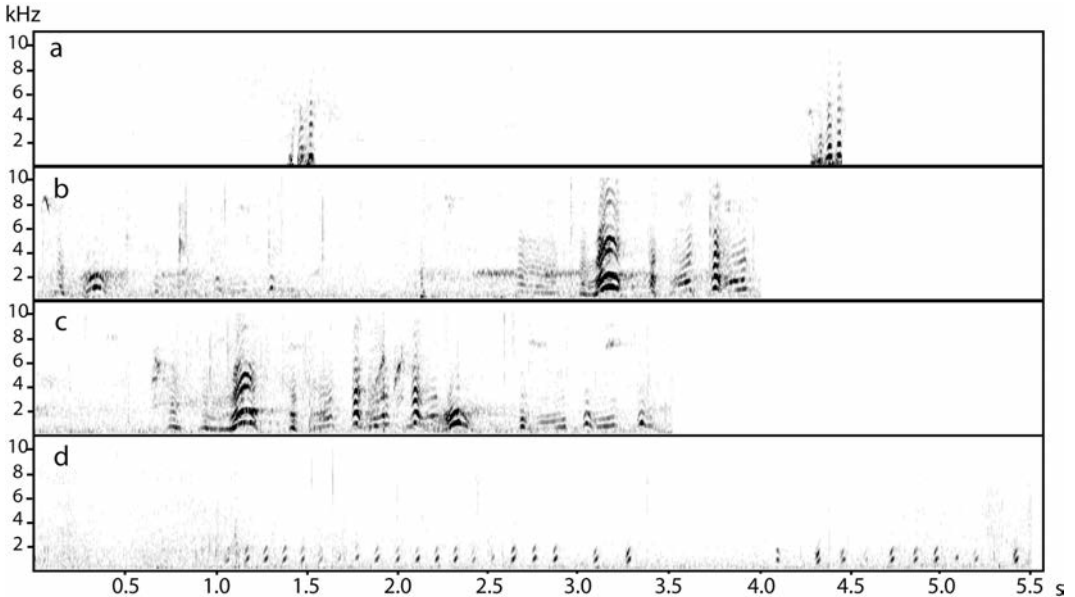


Fig. 3. Sonograms of vocalizations of Chinese grouse (a, b, c – males; d – female): a – trill phrase, b – squeak phrase, c – squeak phrases of two males singing in duet, d – warning call of a female (after a video of S.K., October 13 [3a] and October 14 [3b, c, d] 2013). – *Sonagramme der Lautäußerungen* (a, b, c – Männchen, d – Weibchen): a – Trillerstrophe, b – Quiekstrophe eines Männchens, c – Quiekstrophe zweier Männchen im Wechselsong, d – Warnserie eines Weibchens (Plittern). Nach Videoaufnahmen von S.K., 13. Oktober 2013 (3a) und 14. Oktober 2013 (3b, c, d).

Between 9 a.m. and 2 p.m. aggressions occurred rarely. During intensive feeding to fill the crop before darkness, aggression behaviour is finished.

Two different vocal displays

For territorial advertisement the hazel grouse utters an unique, extremely high-pitched cantus (8 kHz, Bergmann et al. 1996) not comparable with other grouse vocalizations. In the sibling species, the Chinese grouse, the main territorial display is the flutter jump. During border conflicts only, two types of vocal displays at much lower frequency, namely trill or squeak phrases, are uttered. These are not comparable to the vocalizations of hazel grouse.

Trill phrase. The trill is a sharply rising very short (duration 0.16 s) note, composed of 3 very short and densely packed sub elements (Fig. 3a). The interval between two trills was about 3 s in this sonogram. The mean interval within a longer sequence of an intensive dispute averaged 5.8 s ($n = 25$). The trill sounds like a short and clear „trrit“ or „britt“. The frequency range is between

1 and 4 kHz with the main energy output at the lower frequency level. As in the squeak phrase, the overall energy is low. The trill can be noticed by the human ear on a distance of about 20–30 m. In all cases observed, the trill was uttered by only one of the rivals. The other (intruder?) was sitting silent and/or feeding at a distance (>10 m). During trilling the male contracts the neck rapidly, ruffs the neck and throat feathers and the tail is fanned and erected shortly and lowered afterwards. The crest feathers were never erected in this situation (Fig. 5). Sometimes a cackling sound was interrupting the trills, accompanied by a little different behaviour: a male sitting on a stump was bowing, then erecting his neck, turning around, and fanning the tail more conspicuously. In a longer sequence during a 7 min encounter we noted the trill 14 times, interrupted by 7 cackling phrases. While running after a rival, the male stopped, trilled and continued its chasing.

Squeak phrase. The duration of the squeak phrase is about 1 s and the phrase is composed of up to 4 or 7 elements. When starting, two elements of



Fig. 4. a – Male during the first element of the squeak phrase: head bowing with bill open, b – head up and bill closing during the following elements of the phrase (single pictures of a video, October 14, 2013, S.K.). a – *Männchen während des ersten Elements der Quiekstrophe: Kopfbeugen mit offenem Schnabel*, b – *Kopfheben und Schnabel-Schließen während der folgenden Elemente (Einzelbilder eines Videos vom 14. Oktober 2013, S.K.)*.

lower-frequency can be regarded as intention elements. As shown in the sonogram (Fig. 3b), a conspicuous harmonic spectrum of the main elements is responsible for the special nasal-squeaking sound. The mean interval between single phrases within a longer sequence of high activity averaged 15 s ($n = 14$). The overall sound energy is low, the low-pitched signal (2–4 kHz) can be noticed by the human ear at a distance of about 30–50 m. Nevertheless, the sound production seems to be an energy-consuming event: the male's breast is expanded; the first element is produced by a rapid head bowing and opening the bill for 0.33 s. During the whole encounter – during calling, running and even feeding – the crest feathers are fully erected (Fig. 4). This posture is the same as during fighting (see figs. in Klaus et al. 2009a). Often, two rivals use this species-specific phrase in the sense of counter singing. Fig. 3c shows an example. The squeak phrase is uttered in most aggressive situations when the rivals are close to each other or in intervals during fighting (in spring).

Alarm

A sonogram of a longer alarm sequence (like: “tetetetete ...”) uttered by a female during an encounter of nearby males is shown in Fig. 3d.

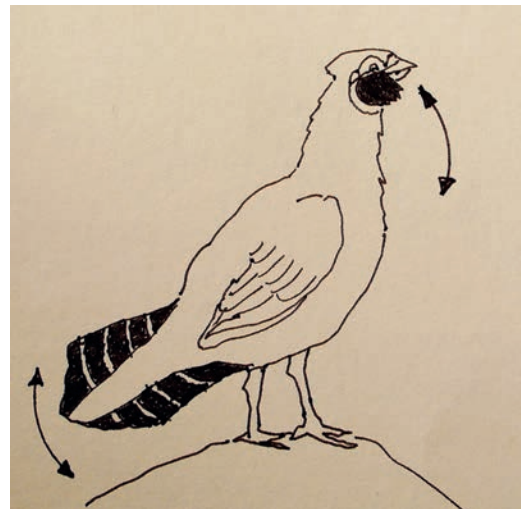


Fig. 5. Typical posture of a male uttering the trill cantus: crest feathers flat, tail fanned and enhanced at the beginning and lowered at the end of the phrase. The bird is turning around, sometimes bowing (after a video of Y.F., May 8, 2012). – *Typische Haltung eines Männchens während der Trillerstrophe: Hollenfedern angelegt, der gefächerte Schwanz wird anfangs gehoben und dann wieder gesenkt. Der Vogel dreht sich am Ort und verbeugt sich mehrfach (nach Video von Y.F., 8. Mai 2012)*.

This long lasting stereotypic phrase contains 9–10 elements/s. The alarm note can be used by males and females as well. The hazel grouse has a very similar note in the same situation (“plittern”, in Bergmann et al. 1996, Scherzinger et al. 2003).

Discussion

In Chinese grouse and hazel grouse, both males and females defend year-round territories throughout most of their range, with peaks of activity in spring and autumn (Swenson 1993, Bergmann et al. 1996). Territorial activity (whistling in hazel grouse only – flutter-jumping, territorial flights and encounters in both species) increases markedly just after the breaking-up of broods in early September/October, when yearlings start to find their own territories. As reported earlier for Chinese grouse (Klaus et al. 2009b), flutter jumps were the dominant territorial performance in spring (87 % of all performances versus 34 % in autumn, $p < 0.001$, Chi²-test), whereas in autumn noisy territorial flights were dominant (45 % vs. 9.3 % in spring, $p < 0.05$, Chi²-test), followed by encounters (21 % vs. 3.7 % in spring, $p < 0.01$, Chi²-test).

As shown in Fig. 1 the frequency of encounters rises slowly during September and culminates in the second decade of October. At the end of this month flock formation starts resulting in a strong decline of aggressions during the third decade of October. Depending on weather situation (snow cover), in November the grouse normally live in flocks (Sun & Fang 1997, Wang et al. 2012) and encounters were no longer observed.

The daily activity pattern of Chinese grouse both in autumn and in spring was biphasic, with peaks in the morning and in the afternoon (Klaus et al. 2009b). This is also valid for encounters (Fig. 2).

When neighbouring males approached each other, conflicts followed. These were accompanied by two types of vocalizations, the trill and the squeak phrase. Encounters were observed on the ground (more frequent) and/or in feeding trees, mainly in willows. The rivals often change from ground to tree and vice versa with very loud flights. The signal effect of these territorial flights is greatly enhanced by noisily hitting twigs with their hard primaries. During the encounter, the males produced their vocalizations often in duet on the ground within the shrubs at distances of

1–20 m from each other. If both rivals ran on the ground, one was chasing the other or they ran in parallel at distances of 1–20 m. During pauses in this chasing, they started feeding and/or uttered one type of the cantus. During the most intensive phase of encounter, the males pecked at the ground or on twigs in a ritualized way. When intensity of aggression declined, true feeding became dominant.

Conflict culminated when males approached each other and stood in an erect pose in front of each other. Synchronous head-bowing followed. Actual fights in Chinese grouse occurred rarely. They consisted of jumping into the air, pecking and loud wing-beating. The crest feathers are always erected during fights (Fig. 6). We observed serious fights and long-lasting chasing runs mainly in spring, very rarely in autumn. The fighting behaviour in Chinese grouse resembles that of Hazel grouse which was very seldom observed and only in spring. Few examples were described by Pynnönen (1954), Teidoff (1952) and Scherzinger (1981), summarized in Bergmann et al. (1996). F. Hafner (unpublished) documented a serious fight in hazel grouse in spring in Amur land (April 28, 2014, Russian Far East). Fig. 7 shows two males in parallel run.

The development of two different types of vocalization used in border disputes seems remarkable. Both types are uttered by males only. Despite the overall low sound energy and limited distance it seems the energy input of males is high. In addition, the disputes – sometimes lasting 10–40 min – may attract predators. We noticed several attacks of goshawk and sparrow hawk, the most effective predators in the study area on the calling grouse. Because most of the encounters took place in the dense cover of shrubby habitat only a part of the attacks were successful.

Summary

In 38 aggressive encounters observed in autumn 77 males were involved. The duration of encounters varied in a wide range (2–77 min, mean 19.7 min). Most of the aggressions occurred on ground ($n = 21$, respectively 55 %, $n = 17$, respectively 45 %) in trees including willow and mountain ash.

In most cases, aggressions started in preferred food trees visited by two neighbours. Often, males moved to both tree species or moved from ground



Fig. 6. Serious fight in Chinese grouse (observed in spring only). The crest of the left male is seriously damaged after several fights (photo Y.-H. Sun, April 21, 2012, Lianhuashan). – Beschädigungskampf zwischen zwei Männchen – bisher nur im Frühling beobachtet: Die Kopffedern des linken zeigen ernste Beschädigung nach diversen Kämpfen.

(Foto Y.-H. Sun, 21. April 2012).



Fig. 7. Parallel run of two aggressive males in hazel grouse *Tetrastes bonasia* along territory border when aggressivity has declined. (photo F. Hafner, April 28, 2014, Amur land, Russia). – Parallellauf zweier Rivalen (Haselhähne *Tetrastes bonasia*) an der Reviergrenze als Teil nachlassender Aggressivität.

(Foto F. Hafner, 28. April 2014, Amurregion, Russland).

to trees and vice versa. 38 aggressions were recorded at 22 sites, indicating that some neighbour males came together repeatedly at the same site. Two different types of vocalizations of the males were observed.

The trill phrase was uttered in 6 cases (16 %). More frequently the squeak phrase ($n = 32$, 84 %) was noticed. During the whole duration of an encounter the type of vocalization did not change. The frequency of encounters rises slowly during September and culminates in the second decade of October. At the end of this month flock forma-

tion starts resulting in a strong decline of aggressions during the third decade of October.

The diurnal pattern of aggression behaviour showed a smaller peak in the morning (at 7 a.m.) and a somewhat higher peak in the afternoon (around 4 p.m.). Between 9 a.m. and 2 p.m. aggressions occurred rarely. Sonograms of the trill and the squeak phrases were described and the accompanying behaviour characterized. Differences between aggressive behaviour in spring versus autumn are discussed and compared with that of hazel grouse.



Fig. 8. Chinese grouse male feeding on *Sorbus khoeniana* berries, a preferred food in autumn (October 6, 2013). – Männchen des Chinahaselhuhns beim Verzehr der beliebten Früchte von *Sorbus khoeniana* (6. Oktober 2013). Foto: Siegfried Klaus.

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