

Breeding biology and nesting behaviour of the little-known white-necklaced partridge, *Arborophila gingica* (GMELIN, 1789) (Galliformes: Phasianidae), at Tierpark Berlin

Fortpflanzung und Nistverhalten des wenig bekannten China-Waldrebhuhns, *Arborophila gingica* (GMELIN, 1789) (Galliformes: Phasianidae), im Tierpark Berlin

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Abstract

The white-necklaced partridge, *Arborophila gingica* (GMELIN, 1789) (Galliformes: Phasianidae), from the southern coastal regions of China has a declining population in the wild and is rarely kept in human care. At Tierpark Berlin, data of the breeding biology and nesting behaviour of this little-known species was collected in 2024. The nest is constructed as a chamber, which is created by forming a little depression and throwing a lot of dead leaves backwards. In total, the breeding pair produced six clutches from March until August. The clutch size varied from one up to six white eggs with an average number of three eggs per clutch. The incubation time ranged from 25 to 27 days. The parents only raised the first clutch successfully. The other clutches were artificially incubated. Five of these chicks hatched and had to be raised by hand. The chicks got closed leg rings with a diameter of 8.0 mm after around 1.5 to 2.5 months. After between 2 to 2.5 months, they have fully moulted into the adult plumage. This manuscript provides details on management, nutrition, and health. The data is compared with the known information about this species and other members of its genus.

Keywords: White-necklaced partridge, *Arborophila gingica*, breeding, nesting, ex-situ, Galliformes

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Introduction

For many bird species, there is still nothing or only little known about their breeding biology. In recent years, more is being discovered and described from in-situ and ex-situ environments. One genus of birds belongs to this group: *Arborophila* HODGSON, 1837, the hill-partridges (Liao et al., 2008; Fu et al., 2020; Lin et al., 2023, Marcuk et al., 2022; Ong-in et al., 2016, Rao et al., 2017). Even though most of the 18-21 accepted species of *Arborophila* were described more than 100 years ago (McGowan, 1994; del Hoyo, 2020; Gill et al., 2025), the breeding biology of many species is still unknown (Grummt, 2014), including *Arborophila gingica* (GMELIN, 1789), the white-necklaced partridge, also known as collared hill-partridge, white-browed hill-partridge or Rickett's partridge – after one of its synonyms (Li Xiao-Hui et al., 1990; Kang, 1969). Besides morphology and habitat ecology, this species is not well researched. Most of it is based on reports of Mell (1922, 1925), Stresemann (1922) and Kang (1969). Its breeding biology is referred to as “virtually undocumented” (McGowan et al., 2020). *A. gingica* is the northernmost occurring species of this genus and inhabits in two subspecies hilly and mountainous forests at 150-1,700 m in southern and southeastern China. The diet is also insufficiently known and reported as seeds, berries and insects (Brazil, 2009; Madge & McGowan, 2010; McGowan et al., 2020). Since 2012, it is classified by the IUCN as “Near Threatened” on the IUCN Red List (BirdLife International, 2024), although it was earlier considered as “Vulnerable” (BirdLife International, 2008), because it was thought to have a much smaller distribution until surveys revealed that it is occurring more widely in the coastal hinterland (Raethel, 1988; BirdLife International, 2012). There appears to be only two published articles that describe the breeding biology of this species which are in human care (Li Xiao-Hui et al., 1990, 1992). There are no scientific reports of its in-situ breeding biology. According to Li Xiao-Hui et al. (1990, 1992), *A. gingica* lays 5-7 white eggs between April and May which are incubated for 23 days. This is consistent with the data of other *Arborophila* species (McGowan, 1994). There have been a small number of articles in the literature on hobby websites and in specialised journals about breeding this species (Husterer, n.d.; Fürstaller & Fürstaller, 2014; Ovelgönne, Stäb, 2021; Stähle, 2022; Ovelgönne, 2024). Because of its seeming rarity in the wild and in human care, it was not mentioned in the earlier major standard works about galliform husbandry, even until recently (Räthel et al., 1976; Grummt, 2014; Asmus, 2021). It apparently started to appear in private collections and zoological institutions only in the 1990s, which is relatively late for a handsome species like *A. gingica*, which was one of the earliest described hill-partridge species (Ovelgönne, 2024). Other species like *A. torqueola* (VALENCIENNES, 1825) and *A. javanica* (GMELIN, 1789) have been kept since the 19th century and are better known (Raethel, 1988). Today *A. gingica* is the most kept species of *Arborophila* (Stäb, 2021; Ovelgönne, 2024). When and where the first ex-situ breeding success took place is not known, but possibly in a private collection in the Benelux countries (Ovelgönne, 2024). In May 2025, there are around 25 holdings in public institutions in Europe, one in Singapore (Zootierliste, 2025; Species360, 2025) and probably a lot more in private collections. One of these institutions is the Tierpark Berlin which focus has been on keeping and breeding galliform species since its foundation in 1955 including *A. gingica*, which provides important additional data on the breeding biology and nesting behaviour of this little-known species in an ex-situ environment. It is described based on data collected in 2024 and compared here with the known information of this and other members of its genus.

Material & Methods

Arborophila gingica has been kept at Tierpark Berlin since 2018 with the arrival of two (2.0) males from the Zoo Ostrava (Czech Republic), with more individuals following the years after

(Tab. 1). There was also a former holding period from 1999 to 2010 (Rudloff, 2000). Since 2018, the individuals of this species have been kept in several different enclosures, with the breeding pair finally placed behind the scenes because it was thought without contact to visitors the quiet would be better for breeding. This enclosure is part of a small building for pheasants and perching birds. The aviary measures 2 m x 6 m (12 m²) and has a height of 2.20 m. The mesh size is 2.5 x 2.5 cm, with a smaller size near the ground with 1.2 x 1.2 cm for protection against predators. Natural soil is used as substrate in the enclosure, covered with a lot of dead leaves. A small sycamore maple (*Acer pseudoplatanus*) grows inside, but grass and herbs only appear briefly, because the position of the enclosure is quite shady and they are destroyed by the digging activities of the birds. Additional enclosure furnishings are a dead branched stem and further branches as well as small shelter. The area next to the building is partially roofed (Fig. 1).



Fig. 1: Enclosure of *Arborophila gingica* at Tierpark Berlin. Photo T. Meschke

The diet plan at Tierpark Berlin consists of ½ apple, ½ lettuce and 100 g pheasant pellets “Fasan Zucht & Unterhalt” from Lundi per animal per day. The pellets are composed of corn, wheat, soybean meal, alfalfa meal, soybeans, corn gluten feed, chalk, grit, brewer’s yeast, seaweed meal, soybean oil and lecithin and contain the following ingredients: raw protein 18%, raw fat, 4.90%, raw fibre 4.10%; raw ash 12.50%, calcium 3.25%, phosphate 0.66%, sodium 0.17%, potassium 0.80% and methionine 0.35%. The diet plan was changed during the observation year. Before the diet was changed, they were fed with 75 g seed mix (⅔ self-made mix of various seeds, ⅓ pigeon feed “Diät & Ruhe” from Rudloff, composed of 27% wheat, 20% barley, 15% milo millet, 12% white dari millet, 6% paddy rice, 6% safflower seeds, 5% linseed, 5% oat kernels, 4% buckwheat), fruit and salad. The mineral supplement Afarom® is sprinkled

on top of the seed mix and shell grit is always offered in the aviary. From time to time the birds receive some mealworms.

The breeding pair is not kept together with other species, but other individuals and the offspring have been socialised after separating them from the parents with Sumatran laughingthrush (*Garrulax bicolor*), Chinese hwamei (*Garrulax canorus*), white-browed laughingthrush (*Pterorhinus sannio*) and Peking robin (*Leiothrix lutea*). There have been no problems with these socialisations. In these mixed enclosures, both species usually ignore each other. The breeding pair as well as most of the offspring are kept entirely outdoors without any indoor area. *A. gingica* is totally cold hardy in the Central European winter in Berlin. The male of the breeding pair was born on 26th April 2021 in the Antwerp Zoo (Belgium), the female on 12th June 2022 in a German private collection. Both arrived at Tierpark Berlin when they were approximately one year old and were placed together after the arrival of the female. For an overview of the population of *A. gingica* at Tierpark Berlin, see Tab. 1. The animals are cared for and observed every day by a team of trained zookeepers.

Results

In February 2024, the pair started to build a nest. They scraped together a mound of dead leaves while forming a little depression in the earth. Then one bird sat down and picked up

Tab. 1: Overview of the population of *Arborophila gingica* at Tierpark Berlin since 2018 (M = Male, F = Female, U = sex unknown).

Sex	Date of birth	Place of birth (arrival at Tierpark Berlin)	Comments
M	09/08/2017	Ostrava Zoo (Czech Republic) (12/12/2018)	
M	09/08/2017	Ostrava Zoo (Czech Republic) (12/12/2018)	
M	26/04/2021	Antwerp Zoo (Belgium) (29/06/2022)	Breeding male
M	12/06/2022	T. Lehmann, private collection (Germany) (09/04/2023)	ex 12/05/2023
F	12/06/2022	T. Lehmann, private collection (09/04/2023)	Breeding female
F	07/04/2024	Tierpark Berlin (Germany)	parent-reared
M	07/04/2024	Tierpark Berlin (Germany)	parent-reared
M	07/04/2024	Tierpark Berlin (Germany)	parent-reared
F	20/07/2024	Tierpark Berlin (Germany)	hand-reared
U	22/07/2024	Tierpark Berlin (Germany)	hand-reared, ex 16/08/2024
U	23/07/2024	Tierpark Berlin (Germany)	hand-reared, ex 25/07/2024
M	18/08/2024	Tierpark Berlin (Germany)	hand-reared, ex 06/10/2024
U	18/08/2024	Tierpark Berlin (Germany)	hand-reared, ex 08/11/2024

leaves and grass blades which it threw backwards while sitting in the depression. This formed a chamber into which they enter through a hole that is sometimes possible to see into (Fig. 2).



Fig. 2: Nest of *Arborophila gingica*. The entrance is on the right. Photo T. Meschke

Three eggs were observed for the first time on 20th March, the exact dates of laying are unknown (Tab. 2). They had a milk-white colour and measured 29 x 40 mm (Fig. 3). After 18 days, three chicks hatched on 7th April. They were precocial and had a chestnut to dark brown down on the back and buff to light brown underparts (Fig. 4). The crown was coloured dark like the back, which borders to a light brown supercilium and then to a dark eyeline. On the back there were two narrow light stripes. Both parents lead the chicks and could stay with them during the rearing. The genetic testing of feather samples revealed that they were 2.1. After 1.5 months the chicks got their individual closed metal leg bands with a diameter of 8.0 mm. Sixteen days after the hatch, one broken egg was found misplaced randomly in the enclosure. To reduce the disturbance for further clutches, the three chicks were separated into another enclosure on 31st May. A complete third clutch of five eggs was laid between the 19th and the 29th of June, but again not inside the nest but loose in the enclosure. It was decided to put them into an incubator by the company GRUMBACH. It was set to a constant temperature of 37.4 °C and a humidity of 60-70%. Two cooling periods per day without heating of 30 minutes each were set. The room where the incubator is placed is used only for the incubation of eggs. It is completely darkened and has a room temperature of 16-17 °C. The eggs were turned automatically nine times around every two hours and additionally turned

Tab. 2: Overview of the clutch developments of *Arborophila gingica* in 2024 at Tierpark Berlin.

Clutch no.	Clutch size	Laying date (= eggs first detected)	Put in the incubator	Hatching date	Incubation period	Comments
1	3 eggs	unknown days before 20/03/2024	/	07/04/2024	>18 days	parent-reared
2	1 egg	23/04/2024 (broken)	/	/	/	egg found misplaced in the enclosure
3	5 eggs	19/06/2024 21/06/2024 23/06/2024 27/06/2024 29/06/2024	26/06/2024 21/06/2024 26/06/2024 27/06/2024 29/06/2024	22/07/2024 (died during hatching) 07/07/2024 (egg died) 20/07/2024 22/07/2024 23/07/2024	27 days / 25 days 26 days 25 days	eggs found misplaced in the enclosure, artificially incubated, hand-reared
4	2 eggs	03/07/2024 05/07/2024	09/07/2024 09/07/2024	15/07/2024 (eggs died)	/	eggs found misplaced in the enclosure, artificially incubated, hand-reared
5	6 eggs	13/07/2024 (broken) 15/07/2024 (broken) 17/07/2024 19/07/2024 21/07/2024 23/07/2024	/ / 24/07/2024 24/07/2024 24/07/2024 24/07/2024	/ / 18/08/2024 (died during hatching) 17/08/2024 18/08/2024 (died during hatching) 17/08/2024	/ / 26 days 25 days 26 days 25 days	eggs found misplaced in the enclosure, artificially incubated, hand-reared
5	2 eggs	14/08/2024 (broken)	/	/	/	eggs found misplaced in the enclosure



Fig. 3: Egg of *Arborophila gingica*. Photo T. Meschke

once per day by hand to simulate the egg turning of the parent animals. After 25-27 days of putting the eggs into the incubator, three chicks hatched. One chick died during the hatching process. During this time the pair had another two misplaced clutches of two and six eggs which were also put into the incubator. The eggs of the first were found to have died, when they were checked after 42-44 days. Of the six eggs of the next clutch, two were found broken and after 25-26 days four chicks hatched, but only two survived. The sixth and last clutch of eggs in 2024 was found on 14th August with two misplaced and broken eggs (Tab. 2).



Fig. 4: 7-days-old chicks of *Arborophila gingica* (25_07_2024). Photo T. Meschke

The artificially incubated chicks were hand-reared after their hatch. They had constant access to water in a shallow ceramic bowl. For feeding, they got finely crushed dry chick starter feed with small amounts of boiled egg and carrot as well as skinned mealworms with mineral supplement. After around a week, they were fed finely crushed seeds of millet and canary seed mix and a small number of herbs (e.g. chickweed, dandelion).

The surviving chicks of the third clutch got their leg rings with a diameter of 8.0 mm after about 2.5 months and the chicks of the fifth clutch when they were 50 days old. After 2-2.5 months they had fully moulted into the adult plumage (Fig. 5). Apparent differences between the sexes could not be noticed. Of the five hand-raised chicks only one survived the first five months. The last two surviving hand-raised chicks, which were of different clutches, were put together for companionship on 8th October, but didn't tolerate each other and had to be separated. But the three parent-reared chicks got on well together. The postmortem results suspected pneumonia and catarrhal enteritis as the reason for the death of the hand-raised chicks.



Fig. 5: 3-month-old female of *Arborophila gingica* (25_10_2024). Photo T. Meschke



Fig. 6: Adult of *Arborophila gingica* with two 51-days-old chicks (28_05_2024). Photo T. Meschke

Tab. 3: Overview of offspring at Tierpark Berlin of *Arborophila gingica* in the keeping period from 1999 to 2010.

Year	Eggs	Chicks
1999 (arrival)	0	0
2000	60	0
2001	42	0
2002	32	3
2003	14	0
2004	3	0
2005	12 in 3 clutches (numbering 5, 3, and 4)	0
2006	0	0
2007	0	0
2008	0	0
2009	0	0
2010 (death of last animal)	0	0

Discussion

The recorded breeding data of *A. gingica* matches mostly with the previous study of Li Xiao-Hui et al. (1992) and the reports from the literature and observations in related species. Husterer (n.d.) describes the start of nest-building in the spring and the same construction behaviour as seen at Tierpark Berlin. He reports that the nest is destroyed almost daily and rebuilt at another location, which could not be observed with the Tierpark animals. Fürstaller & Fürstaller (2014) also report the nest as a ground depression well hidden in dense shrubbery or between grass tufts. From other members of *Arborophila*, the same construction with a chamber created in the ground out of plant material is described (Raethel, 1975; McGowan, 1994, Rao et al., 2017) and seems to be typical for the genus.

Li Xiao-Hui et al. (1992) report for their ex-situ breeding the keeping of large groups with several males and females in one enclosure and average clutch sizes of 6.4. According to their breeding data they laid 5-7 white eggs between April and May which were incubated for 23 days. Other breeding reports from private keepers describe 5-6 eggs (Husterer, n.d.), 5-7 eggs (Fürstaller & Fürstaller, 2014), 2-4 eggs (Stäb, 2021), 3-5 eggs (Ovelgönne, 2024) per clutch and only Stäb (2021) gave an account of a second clutch. At Tierpark Berlin, the breeding pair produced six clutches from March until August. The clutch size varied from 1-6 eggs with an average of 3 eggs per clutch. This matches the previous recorded data, even though the high number of clutches in one year seems to be a great exception. The extensive period of egg-laying of six months in total

also seems to be uncommon, as it exceeds the described two months of Li Xiao-Hui et al. (1992). During the former keeping period at Tierpark Berlin from 1999 to 2010, rough breeding data was also collected (Tab. 3). It shows many eggs, but except for 2005, the clutch sizes were not written down. The number of eggs laid is larger nearly every year in comparison to the 19 eggs in 2024. The peak of laid eggs was in 2000 with 60 eggs recorded and the lowest number 3 eggs in 2004. But the hatching success was very low, probably because the animals also misplaced the eggs constantly and the eggs were not put into an incubator. The hatching of three chicks in 2002, which were parent-raised, is maybe the first or one of the first breeding success in a zoological institution (Zootierliste, 2025), even though the ex-situ breeding in general was probably achieved in a Benelux private collection in 1990ies (Ovelgönne, 2024).

Unfortunately, the exact laying dates of the eggs could not always be determined because of the closed nest construction. The sheltered nest-construction from mostly dead leave-matter serves probably as camouflage against predators. A peek into the nest is possible only when the parent is absent for a short period of time. Depending on how leaves are positioned in that situation, the eggs inside can be seen. The true incubation time of the eggs could therefore not be calculated for certain. The time span of 18 days between first detection of the eggs and the hatching day for the first clutch, is most certainly because the eggs were only discovered some days after the laying date – especially as the chicks in the other two clutches hatched after 25-27 and 25-26 days respectively (Tab. 2). Previous reports name incubation times of 23 days (Li Xiao-Hui et al., 1992; Stäb, 2021) or 24 days (Fürstaller & Fürstaller, 2014; Husterer, n.d.).

Why the breeding pair stopped laying their eggs inside the nest and always misplaced the eggs in the enclosure after the first clutch is not clear. But maybe the flimsy nature of the leaf construction makes it susceptible to destruction and the number of leaves in the enclosure was not sufficient for a repair or reconstruction. The plant species of which the leaves were offered might also have played a role. Maybe the presence of the first chicks could be responsible for the failure of the subsequent broods but does not account for the misplaced clutches after they were separated.

Of the eight chicks that hatched successfully, five had to be raised by hand and only one survived the first five months. The rearing in the outdoor enclosure by the parents proved to be more successful than the hand-raising indoors but was nonetheless possible. Another way for raising artificially incubated *A. gingica* chicks would be foster parents, this should be tested in the future. Ovelgönne (2024) also reports difficulties with hand-raising, especially with the independent food intake, as the chicks did not start feeding on their own first. This could not be observed with the animals at the Tierpark Berlin. Ovelgönne fed them with mealworms and green bottle fly larvae powdered with mineral supplements or moist quail rearing feed and egg feed. The coloration of the chicks also lines up with the described juvenile plumage of the other species of *Arborophila* like *A. torqueola* (McGowan & Kirwan, 2020).

Between the ages of 1.5 and 2.5 months the chicks could be individually ringed with 8.0 mm closed metal bands, which is also recorded by Stäb (2021) and Ovelgönne (2024). In the following year the animals were already capable of reproduction, as one female, born 07/04/2024, already produced fertile eggs in 2025. Husterer (n.d.) describes that they can lay eggs at the age of 6 months, even though most take 2 years. His chicks got along well with each other, which could not be recorded at Tierpark Berlin, where the socialising of two hand-raised chicks from two different clutches did not work out. This makes the large groups of Li Xiao-Hui et al. (1992) with up to 13 animals per enclosure also notable. Both parents take care of the chicks, which is also reported by Ovelgönne (2024) and of other *Arborophila* species by Raethel (1975).

The maximum age of this species has not been recorded yet. At Tierpark Berlin, the oldest animal was 8 years old, hatched 2002 at Tierpark Berlin and died 2010. The currently kept animals are also reaching the age of 8 (Tab. 1, Status 06/2025).

In contrast to Ovelgönne (2024) and in accordance with Husterer (n.d.), *A. gingica* is completely winter-hardy in Berlin and probably most parts of Germany. For several years, individuals of this species lived only in outdoor enclosures without problems. Some shelter is of course needed, as it protects against extreme weather. Ovelgönne (2024) points out the importance of a soft substrate similar to a forest floor, because it keeps the legs healthy and encourages extensive scratching.

Even though complete documentation of all reproduction measurements was not possible, the data described here provides important information about the breeding of this rarely kept and in its natural habitat decreasing species. The data described must still be confirmed by observing the animals in their natural habitat, which underlines the importance of scientific data collection in ex-situ environments.

Conflict of Interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Zusammenfassung

Das China-Waldrebhuhn oder die Chinabuschwachtel, *Arborophila gingica* (GMELIN, 1789) (Galliformes: Phasianidae), aus den südlichen Küstenregionen Chinas hat einen rückläufigen Bestand in der Natur und wird selten in menschlicher Obhut gehalten. Im Tierpark Berlin wurden im Jahr 2024 Daten zur Brutbiologie und zum Nistverhalten dieser wenig bekannten Art gesammelt. Das Nest wird als Kammer gebaut, die durch eine kleine Vertiefung und das Zurückwerfen einer großen Menge toter Blätter entsteht. Insgesamt produzierte das Brutpaar von März bis August sechs Gelege. Die Gelegegröße variierte von einem bis zu sechs weißen Eiern mit einem Durchschnitt von drei Eiern pro Gelege. Die Brutzeit reichte von 25 bis 27 Tagen. Nur das erste Gelege wurde von den Eltern erfolgreich aufgezogen. Die anderen Gelege wurden künstlich ausgebrütet. Aus diesen schlüpften fünf Küken, die von Hand aufgezogen wurden. Die Küken bekamen nach etwa 1,5 bis 2,5 Monaten geschlossene Kennzeichnungsringe mit einem Durchmesser von 8,0 mm. Nach 2 bis 2,5 Monaten haben sie vollständig in das adulte Federkleid gemausert. Es werden Einzelheiten zu Haltung, Ernährung und Gesundheit beschrieben. Die Daten werden mit den bisher bekannten Informationen über diese und andere Arten der Gattung verglichen.

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