Field observations of Pere David's Owl (*Strix davidi*) in central China,140 years after its first description

Observações da coruja de Sichuan (*Strix davidi*) na China central, 140 anos após a descrição da espécie

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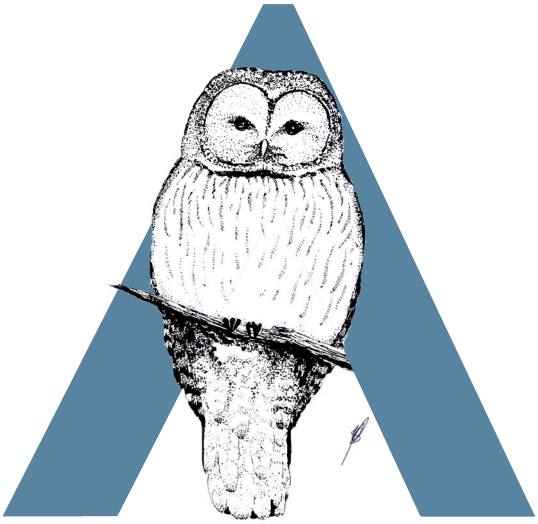


ABSTRACT

Due to the detection of Pere David's Owls in Lianhuashan Reserve, in Province of Gansu, we collected data on appearance, plumage, vocalization, behaviour and breeding activity of at least two territorial pairs. Our aim was to actualise our knowledge of this rare species, as observations are largely lacking since the first collection of a specimen by Pere David in 1869. From 1995 we managed systematic documentations by photographs and nest-box-videos, tape recordings, measurements of fledglings, and protocols of courtship, copulations, prey-delivery and feeding of fledglings, as well as nest defence and attacks against enemies within several stays in the reserve. Up to 2017 we could confirm > 15 broods, with a minimum of 23 nestlings. Our results allow a basic revision of the general description of Pere David's Owl, as misleading characters are labelled in literature, caused on the one hand by wrong interpretations of the original description by Sharpe in 1875, and by fundamental confusion of several owl species, named synonymic in the 19th century on the other hand. We present photographic documents of male and female plumage, of eggs, nestlings, and fledglings for the very first time. A first step is done, to design

the structure of the vocal inventory, but sonographic analysis is still open. Future projects should also clarify the prey-list in concern to local fauna. Comparisons of appearance, plumage, and vocalization of *Strix davidi* and *Strix uralensis* confirm that these species match in main characters, and are to merge in a "super-species".

Keywords: habit and plumage, *Strix davidi*, taxonomic comparisons, vocalization

RESUMO

Devido à deteção de coruja de Sichuan na Reserva Lianhuashan, na província de Gansu, recolhemos dados sobre aspeto geral, plumagem, vocalizações, comportamento e atividade reprodutora de pelo menos dois casais. O objetivo era atualizar o conhecimento sobre esta espécie rara, uma vez que existem muito poucas observações desde a recolha do primeiro espécime por Pere David em 1869. Nas várias visitas que efetuámos à reserva desde 1995, recolhemos registos sistemáticos através de fotografias e vídeos em caixas-ninho, gravações áudio, biometrias de juvenis e comportamentos de corte, copulação, entrega de presas e alimentação de juvenis, bem como defesa do ninho e ataques de intrusos. Até 2017 confirmámos mais de 15 ninhadas, e o número mínimo de 23 juvenis. Os nossos resultados permitem uma revisão básica da descrição da coruja de Sichuan, uma vez que existem características incorretamente descritas na literatura. Estas devem-se, por um lado, a interpretações erradas da descrição original de Sharpe em 1875 e, por outro, por confusão entre várias espécies consideradas sinónimas no século XIX. Apresentamos pela primeira vez fotografias da plumagem do macho e da fêmea, de ovos, e de juvenis no ninho e na fase de emancipação. Damos o primeiro passo no sentido de desenhar a estrutura do inventário vocal da espécie, no entanto, ainda será necessária a análise de sonogramas. Estudos futuros deverão ainda clarificar a lista de presas no contexto da fauna local. Comparações do aspeto geral, plumagem e vocalizações entre *Strix davidi* e *Strix uralensis* confirmam que estas espécies apresentam muitas características comuns e podem formar uma "super-espécie".

Palavras-chave: comparações taxonómicas, hábitos e plumagem, *Strix davidi*, vocalização

Introduction

In 1869, during his famous expedition in the mountainous forests of the Chinese Province of Sichuan, the French missionary Pere Armand David shot a wood-owl near Moupin (today Baoxin), different from other well known species. Due to the owl's size and its relatively dark plumage David (1871) believed this specimen was the Ural Owl of southern Japan, and therefore named it *Ptynx fuscescens*. Consecutively Jules Verreaux from the National Museum of Natural History in Paris determined this owl as *Ptynx fulvescens* (what was criticised later, as this name fits an owl species known from Guatemala/Central America). But, when sent to the British Museum, Sharpe (1875) recognized in this male specimen a new species, clearly differentiated from the more common Himalayan

Figure 1 - Pere David´s Owl looks strong and powerful. Its appearance is characterized by a dark plumage in dull brown and coarsely marked. Mostly active in dawn and night, the big wood-owl hunts also in full daylight during the breeding season. (Female chasing mobbing crows; Lianhuashan Reserve 2012).

Figura 1 - A coruja de Sichuan parece forte e robusta. O seu aspeto geral é caracterizado por plumagem castanho-escura baça com marcas grosseiras. Apesar de estar ativa sobretudo durante a noite e ao nascer do sol, no período reprodutor esta grande coruja tipicamente florestal também caça durante o dia. (Fêmea em perseguição de corvídeos que a tentavam atacar; Reserva de Lianhuashan 2012).

Owl (*Strix nivicola*), the Ural Owl (*Strix uralensis*) and Great Grey Owl (*Strix nebulosa*). He named the Moupin-owl *Syrnium davidi*, in respect to its collector. The very first depicture of this owl species was published under this new name by David & Oustalet (1877).

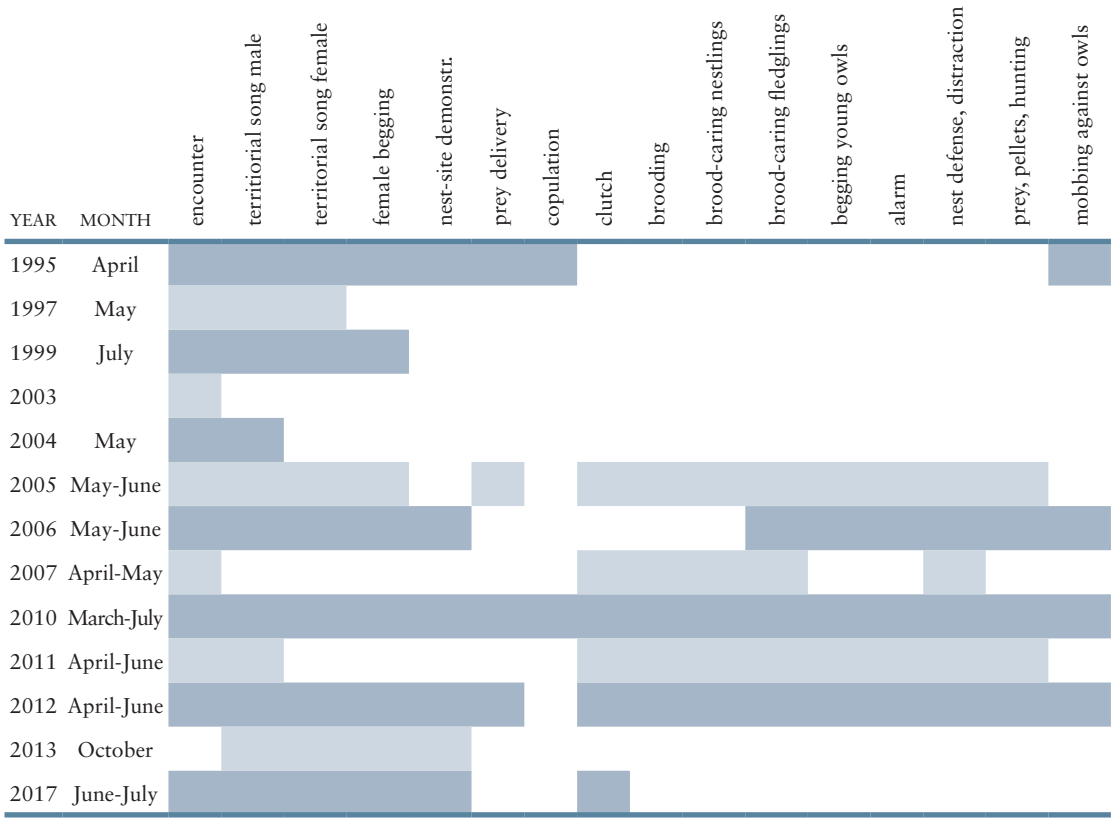
Apart from a second male, which was collected around 1914 by H. Weigold in Hwang-lung-sze (southern Sichuan Province, see map in Fig. 8) and described by Stresemann (1923), a third exemplar (a male also) was shot in the Sichuan Province by Smith 1931 (in Traylor 1967). In the local museum of the Lianhuashan Reserve a further specimen is on exhibition, poorly mounted, but probably a female (Scherzinger 2005). Although photos of Pere David's Owl were posted sporadically on the internet during recent years (mostly from northern Sichuan Province, especially from Jiuzhaigou National Park; Tab. 5-b), focused studies on this rare bird still are lacking since its first description 140 years ago.

Methods and study areas

Due to the detection of at least two territorial pairs of Pere David's Owl in Lianhuashan Reserve (southern Province of Gansu, Central China; 34°56-58´N, 103°44-48´E; Sun et al. 2001), we collected data on appearance, plumage, vocalization, behaviour and breeding activity (Fig. 1). Our aim was to improve knowledge on this species by systematic documentation during several campaigns in the

Table 1 - Timetable of stays in Lianhuashan Reserve, 1995 to 2017. By shifting times we covered all important seasons by field studies within 20 years. (Breeding activity of *Strix davidi* in nest boxes from 2005).

Tabela 1 - Calendário das estadias na Reserva de Lianhuashan, de 1996 até 2017. Ao alternar entre vários períodos do ano, abrangemos todas as fases importantes do trabalho de campo ao longo de 20 anos. (Atividade reprodutora de *Strix davidi* em caixas-ninho desde 2005.)

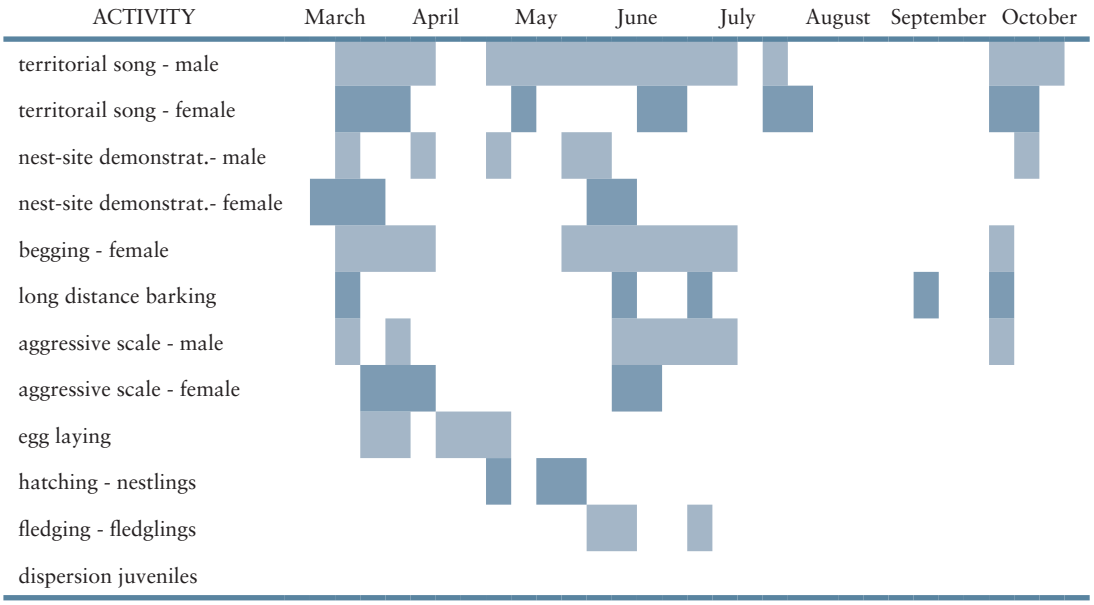


field. From our first discovery of a singing male in 1995 until 2017 we invested 14 visits to this forest-reserve, in different seasons (Tab. 1). In the years between our activities were limited to incidental findings and sporadic nest-controls only. Beside this main study area we visited the Jiuzhaigou National Park (Sichuan Province) twice, with its famous relicts of primary forests. Here we managed to record vocalizations of two males.

The Lianhuashan Reserve is situated in the limestone mountains at the eastern border of the Tibetan plateau. This area was confirmed as hotspot of biodiversity, as three distinct geographic zones, four separate landform zones (Eastern Monsoon Zone, Qinghai-Tibet Alpine-cold Zone, and North-western Arid Zone), five floristic zones, and six faunistic sub-zones meet here (Lei et al. 2006, Linxin 2013). Therefore the former provincial Forest Reserve was ranked as National Nature Reserve. It covers about 12,550 ha of high mountainous and alpine landscape, reaching elevations of 3,578 m at its highest summit ("Lotus Mountain", idolized as a Buddhist sanctuary). Due to extensive areas above the timberline and dry thorn bush on sunny slopes, older coniferous forest of suitable habitat for large wood-owls is limited to only 1,170 ha. Although the forest lost older age classes due to logging in the 1980's, today tree-stands can be classified as rather natural, in concern to their autochthonous origin and their diversity of trees, bushes and fur-

Table 2 - Summation of phenological data on *Strix davidi* in Lianhuashan Reserve, from 1995 to 2017: time of egg-laying may span over 4 weeks, and territorial song of males reach from early spring to late summer, and can also be heard in autumn occasionally.

Tabela 2 - Resumo dos dados de fenologia de *Strix davidi* na Reserva de Lianhuashan, de 1995 a 2017: as posturas podem ocorrer durante 4 semanas, e o canto territorial dos machos ocorre desde o início da primavera até ao final do verão, podendo ainda ser ouvido ocasionalmente no outono.



ther vegetation. Habitats are dominated by fir (*Abies fargesii*) and spruce (*Picea aspera*, *P. purpurea* and *P. wilsonii*), which grow mostly on humid slopes in northern exposures (Fig. 2).

Due to an obvious lack of breeding sites in the younger tree stands, natural nest sites on broken tree-stumps or in large tree-cavities are largely absent, and as a result the owls breed in perilous rock crevices. Because of the rough terrain, nesting sites are extremely hard to find in the rocky faces. Therefore about 40 spacious nest-boxes were mounted, enabled by support of the British Petrol Conservation Programme (Fang 2005). This infrastructure was immediately accepted by the owls, and enabled us to know courtship and breeding activity for the very first time. We made systematic life-history documentation through photographs and videos, tape recordings, protocols of courtship, copulation, prey-delivery and feeding fledglings, as well as nest defence and attack against enemies (Fig. 3). Long-time management of breeding, release and monitoring of Ural Owls in the Bavarian Forest National Park, Germany, provided us with comparisons of appearance, behaviour, and vocalizations in this closely related owl species (Scherzinger 2006).

Results

Phenology and reproduction

Due to our shifting schedule, our observations covered the courtship-season from the middle of March to the middle of April, and the time of breeding and rearing the offspring from the beginning of May to the middle of July. Although territorial activity is also performed in autumn, we could only be present during some weeks in October (Tab. 1, 2).

Figure 2 - Typical habitat of *Strix davidi* in Lianhuashan. Within the reserve of 120km2 about 12km2 of mountainous forests are available for the owls, at elevations between 2,500-3,100m above sea level, dominated by fir and spruce in northern slopes, by shrubs and pastures in southern slopes. Although the forest loss high age classes by logging in the 1980-ies, today tree stands can be classified as rather natural in concern to their autochthonous origin and their diversity in trees, bushes and further vegetation.

Figura 2 - Habitat típico de *Strix davidi* em Lianhuanshan. Dos 120 km2 da reserva, estão disponíveis para as corujas 12 km2 de floresta de montanha com elevação entre 2200 e os 3100 m de altitude, dominados por abetos e coníferas nas encostas a norte, e por arbustos e pastagens nas encostas a sul. Apesar do desaparecimento das árvores longevas nesta floresta, devido à exploração desde os anos 1980, atualmente os povoamentos florestais podem ser classificados como naturais, tendo em conta a sua origem autóctone e a diversidade do extrato arbóreo, arbustivo e demais vegetação.

Albeit fragmentary, the phenological data of territorial song, courtship, and breeding show a broad variety in timing: from the middle of March at least the territorial song of male and female are performed on a high level, accompanied by aggressive scales and occasional long-distance barking (Tab. 2). While the male keeps on singing (with a broad variety of full territorial song, soft song, reduced song with introductory or finishing syllables only) until moulting in the middle of summer, the female changes to begging notes as soon as she gets ready to breed. This vocalization goes along the whole of the breeding season, in highly variable enunciation. While examining different breeding sites, both sexes utter soft notes of an ascending scale during the nest site evaluation (Tab. 7).

Egg laying mostly started at the beginning of April, but in some years was delayed for up to 4 weeks. This might be dependent on weather condition or/and low accessibility of prey, due to a persistent snow cover in early spring. In such cases fledglings may leave the nest box as late as the beginning of July. In 2014 we documented the predation of a freshly laid egg by a Siberian Weasel (*Mustela sibirica*). But we cannot explain why females abandoned their clutch in some years – just after laying the first eggs (e.g., in 2017; Fig. 4).

Figure 3 - Due to an obvious lack of breeding sites in the growing up tree stands, a good number of spacious nest-boxes were mounted, what attracted the owls – and enabled us getting to know courtship and breeding activity for the first time ever.

Figura 3 - Devido à grande escassez de locais de nidificação nos povoamentos florestais em crescimento, foi instalado um elevado número de caixas-ninho, o que atraiu as corujas – e possibilitou o estudo do comportamento de corte e reprodução da espécie pela primeira vez.

Figure 4 - As is typical for owls, the eggs of *Strix davidi* are nearly pure white also, with a fine grained surface. Surprisingly the measures of single eggs can differ distinctly (eggs from two abandoned clutches; Lianhuashan Reserve 2017).

Figura 4 - Tal como é típico nas rapinas noturnas, os ovos de *Strix davidi* são claros e com uma superfície finamente granulada. As medidas podem diferir marcadamente entre ovos (ovos de duas posturas abandonadas; Reserva de Lianhuashan 2017).

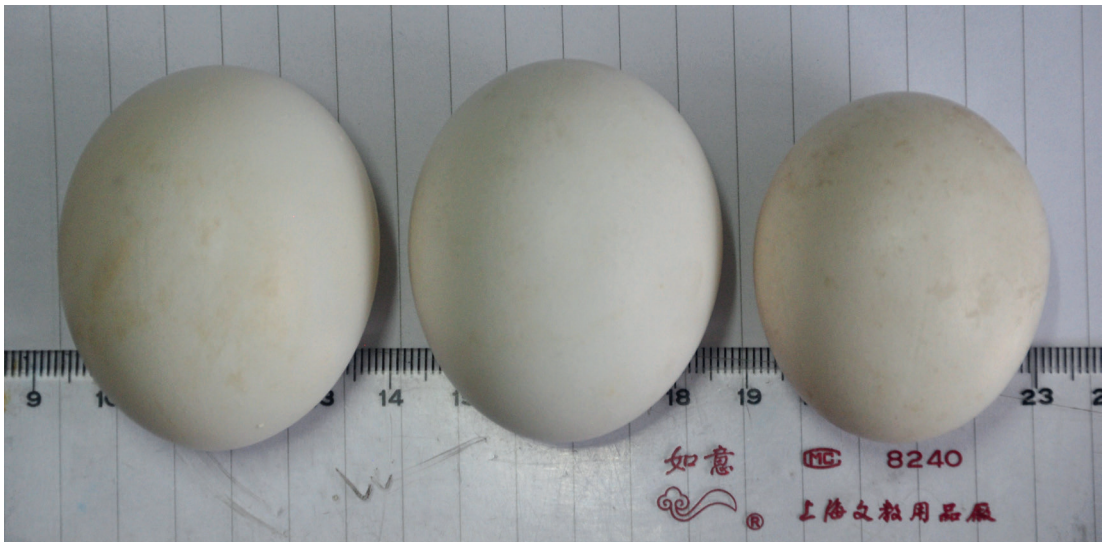


Table 3 - Measures and weight of eggs of *Strix davidi* in Lianhuashan Reserve: Due to the supply of several nest boxes we could collect some eggs for measurements (3 from abandoned brood, 5 freshly laid). Size and weight between eggs differ substantially.

Tabela 3 - Medidas e peso de ovos de *Strix davidi* na Reserva de Lianhuashan. Devido à instalação de várias caixas-ninho foi possível recolher alguns ovos para medição (3 de posturas abandonadas, 5 de posturas recentes). O tamanho e o peso variaram substancialmente entre ovos.

BROOD YEAR	MEASURES OF EGGS - MM			WEIGTH - G	
	max. length	breadth 1	breadth 2	egg shell	whole egg
2005	49.1	42.2			41.5
	50.1	40.8			42.1
2010	53.0	42.4			52.1
	53.4	42.5			53.2
2012	50.0	41.0	40.0	4.3	
2017	47.8	40.2	40.0	3.4	35.4
	52.4	43.6	44.0	(4.7)	54.0
	52.4	43.0	43.2	3.9	52.5
mean	51.1	42.0	41.8	4,1	47.3

Table 4 - Due to a strict dependency on sufficient prey abundance, the demanding wood-owls do not breed in years with a shortage of prey. As clutch size and number of fledglings are astonishingly low, the rate of reproduction seems alarming insufficient. Within 12 years we confirmed 6 breeding attempts in the eastern pair, and 9 attempts in the western pair, with only 16 fledglings altogether (1.5 and 2.2 young per successful broods).

Tabela 4 - Devido a uma forte dependência da abundância de alimento, as corujas florestais não se reproduzem em anos de escassez de presas. Uma vez que o tamanho da postura e o número de juvenis voadores são muito baixos, a taxa de reprodução parece criticamente insuficiente. Em 12 anos confirmámos 6 tentativas de reprodução do par com a localização mais oriental, e 9 tentativas do par mais ocidental, resultando na produção de apenas 16 juvenis voadores (1,5 e 2,2 juvenis por ninhada com sucesso).

Reproductive activity of *Strix davidi*, in the Lianhuashan Forest Reserve

YEAR	TERRITORIES	PAIRS	BREEDING ACTIVITY	BREEDING SITE	EGGS	NESTLINGS	FLEDGLINGS	YOUNG OWLS
1995	> 1	A-Line	probably	rock cave ?				
1997	> 1	B-Line	possible					
1999	> 1	B-Line	possible					
2003 2004	about 40 nest boxes offered							
2005	> 2	B-Line	confirmed	nest box	2	2	2	2
		rocky crest	confirmed	unknown	> 1	> 1	0	0
2006	4 ?	B-Line	possible					
		rocky crest	confirmed	rock crevice	> 2	> 2	2	?
2007	> 2	B-Line	confirmed	nest box	3	3	3	0
		rocky crest	confirmed	rock crevice	> 2	> 2	0	0
2010	> 2	B-Line	confirmed	nest box	2	2	2	2
		rocky crest	possible					
2011	> 2	B-Line	confirmed	nest box	1	1	0	0
		rocky crest	confirmed	nest box	> 3	3	?	?
2012	> 2	B-Line	confirmed	nest box	> 2	2	2	?
		rocky crest	confirmed	nest box	2	1	1	?
2013	> 2	B-Line	confirmed	unknown	> 2	> 2	> 2	2
		rocky crest	possible					
2014	> 1	B-Line	confirmed	nest box	2	0	0	0
2015	> 1	B-Line	confirmed	nest box	> 2	2	2	2
		rocky crest	unknown					
2016	(2)		unknown					
2017	> 3	A-Line	possible					
		B-Line	confirmed	nest box	2	0	0	0
		rocky crest	confirmed	nest box	1	0	0	0
S	2 - 4	2 - 3	15		> 29	> 23	> 16	> 8
mean			confirmed		1,9	1,5	1.0	0,6

Figure 5 - *Strix davidi* nestlings leave their nesting site in age of about 4 ½ weeks. Fledglings are characterised by a fluffy and wooly mesoptile, with a dark facial disc and pink eye-lids (Lianhuashan Reserve 2012).

Figura 5 - Os juvenis de *Strix davidi* deixam o ninho com cerca de 4,5 semanas de idade. Os juvenis voadores apresentam mesóptilo macio, disco facial e pálpebras cor-de-rosa (Reserva de Lianhuanshan 2012).

Although we confirmed full courtship, with prey-deliveries and copulation in 1995, data on reproductive success are scarce for the years without artificial nesting sites, and mostly based on observations of rangers or mushroom collectors in the reserve. Breeding attempts in the rocky cliffs are extremely hard to discover, but rangers reported remnants of nestlings, which had fallen from such an exposed nesting site in former years. Beside such accidental records we were able to detect a successful brood with 2 fledglings in the eastern rock area in 2006. But due to the nest box project we were able to confirm a total of 11 breeding attempts in these artificial sites, beside another one in the western forest area and at least two in the rocks; the outcome of this are 15 breeding attempts from 2005 through 2017.

Considering the high risk of nest abandonment by disturbed females, we principally avoided checking the clutch size when the female was incubating. Altogether we were able to measure eight eggs from four clutches (5 freshly laid, 3 abandoned but still fresh). The average weight was 47.3 g, length was 51.1 mm, and breadth was 41.8 mm, but single eggs differ in size to an astonishing degree (Tab. 3). By avoiding any unnecessary disturbance we had to estimate the number of eggs relative to the number of nestlings in several years. In 13 years of monitoring (2005 - 2017) we confirmed 15 broods (of two pairs), with a minimum of 29 eggs and 16 confirmed fledglings. On average, this means 1.1 eggs per pair and year, and 1.9 eggs per clutch, respectively. In consequence we recorded an average of 0.6 fledglings per pair and year, and 1.0 fledgling per confirmed breeding-attempt. With regard to successful broods, we recorded an average of 1.5 fledglings in the eastern pair (in the rock-area) and 2.2 fledglings in the western pair (in the forest area; Tab. 4).

This alarming low success of reproduction may be caused by a fundamental lack of an abundant main-prey. Although we collected all the remnants from nest boxes and monitored partly prey deliveries at the nesting site, the prey list of *Strix davidi* in the mountainous forest is quite incomplete. The largest items were Flying Squirrel (*Aeretes melanopterus*, > 500g), Chinese Grouse (*Bonasa sewerzowi*, 350g), and Northern Nutcracker (*Nucifraga caryocatactes*, 150g). More common were Pika (*Ochotona dauurica*), Hamster (*Cansumys canus*), diverse mice and medium sized birds (e.g., Elliot's Laughingthrush, *Garrulax elliotii*).

The species´ description needs a revision

As all the depictures in literature of *Strix davidi* are based on the descriptions of only two embalmed museum specimens (type from David in Paris, male – described by Sharpe 1875, Sharpe & Gunther 1875; specimen from Weigold in Dresden, male – described by Stresemann 1923), they show a broad variety of characters - even wrong ones. Especially the quite confusing comparisons with Ural Owl and Great Grey Owl in Sharpe´s first description of *Syrnium davidi* (1875) misled some artists to pass characters of these species to the image of Pere David's Owl - by mistake. In consequence these images erroneously show strong concentric rings in the facial disc (assigned from *Strix nebulosa*), also horizontal lines on feathers of breast and belly (assigned from *Strix nivicola*; König & Weick 2008), faintly spotted rings in facial disc (del Hoyo et al. 1999), bow-shaped eyebrows and chequered pattern in facial disc (Eck & Busse 1973), or a white coronoid band on the upper rim, and barred central tail feathers (Mac-Kinnon & Phillipps 2000; Fig. 5).

Figure 6 - Due to quite confusing comparisons with Ural Owl (*Strix uralensis*) and Great Grey Owl (*Strix nebulosa*) in Sharpe´s text (1875), some artists passed characters of these species to the image of *Strix davidi* - by mistake. Therefore depictions in literature differ considerably in several characters.

Figura 6 - Devido a comparações confusas com a coruja dos Urales (*Strix uralensis*) e coruja-lapónica (*Strix nebulosa*) no texto de Sharpe (1875), alguns artistas representaram por engano algumas características destas espécies em *Strix davidi*. Por esse motivo, as descrições de algumas características na literatura diferem consideravelmente.

Figure 7 - *Strix davidi*'s appearance is identified by a bulky head, with dark brown eyes in a tiny mottled facial disc, which is framed by a dark pearl-spotted rim. The forceful body is covered by a dull brownish plumage, with coarse dots on wing and shoulder. The long tail is typical for large wood-owls, like the related Ural Owls (photo: Lianhuashan Reserve).

Figura 7 - O aspeto geral de *Strix davidi* é caracterizado por cabeça volumosa, com olhos castanho-escuros num pequeno disco facial pintalgado, delimitado por um rebordo com pintas escuras. O corpo robusto é coberto por plumagem acastanhada com pintas largas nas asas e escapulares. A cauda é longa, típica das corujas florestais como a coruja dos Urales (foto: Reserva de Lianhuashan).

Figure 8 - Pere David´s Owl´s size is similar to the largest subspecies of Ural Owl (*Strix uralensis macroura*), but differs by its dull darkish brown appearance. When highly excited, the facial disc gets spread maximally, performing its whitish pearl spotted rim and patches beside the beak also (aroused female during researchers nest inspection; Lianhuashan Reserve 2012).

Figura 8 - A dimensão corporal da coruja de Sichuan é semelhante à da maior subespécie de coruja dos Urales (*Strix uralensis macroura*), mas a primeira distingue-se pela sua aparência baça e castanho-escura. Quando excitada, o disco facial expande-se, exibindo o seu rebordo escuro com pintas brancas e também as manchas brancas dos lados do bico (fêmea excitada durante a inspeção do ninho pelos investigadores; Reserva de Lianhuashan 2012).

Based on direct field observations and a great number of photos, but also on the specimen in the Lianhuashan collection, we are able to revise the description of *Strix davidi* in critical characters: As Stresemann (1923) diagnosed, Pere David's Owl appears much darker and duller in its basic colour than Ural Owls or Great Grey Owls. Due to the species´ appearance in our study area the plain dark chocolate-brown shoulders seem to be characteristic, which turns in the backside of similar colour, down into the unicoloured, brown tail coverts. In accordance with Sharpe & Gunter (1875) a row of coarse, whitish drops runs along the border between the scapulars and lesser wing coverts. A similar pattern runs across the wing (Fig. 6). The light coloured breast feathers are marked with dark stripes, arranged denser and broader on the upper part. Crossing bars of dull ochre may occur on belly and flanks.

Plumage on forehead is of mottled brown, what contrasts with a white pattern, forming a clear V. In concern with changing behavioural moods, this conspicuous pattern may appear in variable shapes. The facial disc is nearly circular in males, but more broad-oval in females. It is framed by a dark rim with contrasting white pearl-spots. The disc's surface is mainly marked by darker radial streaks. As is typical for owls, the shape and extent of the "face" may vary by mimic expression: In camouflage posture the disc gets pressed laterally and the contrasting white patterns get covered. But when highly excited, the owl presents not only the fully spread pearl-spotted facial rim, but in addition two white half-moon-shaped patches aside the chin, separated by dark feathers below the beak (Fig. 7). Bushy bristles beside the beak reach down to the "cheeks". The beak is light to deep yellow. The corners of the beak are fleshy coloured.

The colour of the dark brown eyes contrasts not only with the pinkish eyelids but also with a light ring, framing the eye. Black superciliar "eye-shadows" demarcate the disc to the whitish bushy eyebrows, which determine the strong facial expression.

Tarsi and toes are densely plumed and furry, with a fine marbling pattern. The strong and long claws are of corneous ochre to grey. Except the central feathers the fanned tail shows three crossing bars on the upper side, and four bars on the underside. The undertail coverts are marked by coarse and dark crossbars. The central, slightly pointed tail feathers are prolonged and of dark brown colour, in some cases marked with inconspicuous scribbling (Scherzinger et al. 2014).

In his first description Sharpe (1875) pointed at the uniform and dark brown colour of the central feathers in *Syrnium davidi*, what was confirmed with the second specimen by Stresemann (1923), and therefore this character got emphasized as species specific. But all descriptions of *Strix davidi* in the literature are based on male specimens. Comparing the tail feathers of the specimen of the Lianhuashan collection (which probably is a female) the central feathers show some dots and light bars (Fig. 8). The free-ranging female in the reserve clearly showed the same "aberrant" pattern. In this concern an examination of more individuals could clarify if sexual dimorphism in this owl is possible.

Due to increasing interest in the fauna and flora in China, specialised organisations bring birdwatchers from the entire world to the remotest mountains in Yunnan, Sichuan, Gansu, and even at the Tibetan Plateau, especially to sample the famous endemic bird fauna (Tab. 5-a). Therefore a large number of records, observations and photo-documents of *Strix davidi* have been acquired during the last 12 years. By correspondence, obscure literature, and the internet, we accumulated about 30 photos (four from Gansu Province, 26 from Sichuan Province and eastern Tibet, respectively), and seven records of observations in the forests of Sichuan (mostly from Gonggangling Pass and Jiuzhaigou National Park; Tab. 5-b). In summation these records from the recent past help to enlarge and specify our knowledge of the distribution and habitat characteristics of this still relatively unknown owl species.

Table 5a - In the recent past a relevant number of organisations offer special birdwatching tours to remote mountain areas, to seek rare endemics of Chinese avifauna, including Pere David´s Owl in particular (following the internet, rare guided tours accumulate at Gonganggling Pass and in Jiuzhaigou National Park).

Tabela 5a - No passado recente, um elevado número de organizações ofereceu visitas especiais de observação de aves a àreas montanhosas remotas, para procurar espécies endémicas e raras, incluindo a coruja de Sichuan (segundo informação online, as visitas guiadas para observação de raridades de avifauna ocorreram sobretudo em Gonganggling e no Parque Nacional de Jiuzhaigou).

Prospective observations of Pere David´s Owl (from internet searches 2017)				
PROVINCE	LOCATION	PHOTO	OBSERVATION	GUIDED BIRDWATCHER TOUR
Sichuan	Gongganglíng	•		China-Birding-Tour
Sichuan	Gongganglíng	•		Summer-Wong-Bird-Tours
Sichuan	Gongganglíng	•		heatherlea, UK Birdwatching
Sichuan		•		Ph. He - Alpine Birding´s
Sichuan	Gongganglíng		•	Tropical Birding
Sichuan	Gongganglíng		•	China Dreams Tour
Sichuan	Gongganglíng		•	Rockjumper Birding Tours
Sichuan	Jiuzhaigou		•	China-Holidays-Tour
Sichuan	Jiuzhaigou		•	Bird Finders - Birdwatching
Sichuan	Jiuzhaigou		•	Splendid China Tours
Sichuan	Jiuzhaigou		•	Wings Birding Tours
Sichuan	Jiuzhaigou		•	Sichuan Highlight Birding Tour
Sichaun	Jiuzhaigou		•	Birding Eco Tours
Sichuan	Jiuzhaigou		•	Panda China Tour
Sichuan	Baizha		•	Jason Tour / China Exploration
Sichuan-W	Minya Konka		•	Western Sichuan Tours
Sichuan	Ruoergai		•	Bird-Quest-Tour
Sichuan	Tangjiahe		•	Parrotbill-Tour
Sichuan	Wanglang		•	Donald Camac - Birding Asia
Sichuan	Wawushan		•	South China Birder

Table 5b - Since China opened up for tourism, a surprising number of ornithologists and birders got the chance to experience the outstanding diversity of avifauna in even remote areas of this huge country. Therefore the number of field records of *Strix davidi* increased promptly during the last decade (data from literature and internet). Observations and photos contribute to our knowledge of distribution and habitat characteristics.

Tabela 5b - Desde que a China se abriu ao turismo, um elevado número de ornitólogos e observadores de aves tiveram a oportunidade de experienciar a extraordinária diversidade da avifauna deste vasto país, incluindo em áreas remotas. Consequentemente, o número de registos de *Strix davidi* aumentou rapidamente durante a última década (segundo dados na literatura e online). Observações e fotografias contribuíram para o conhecimento da distribuição da espécie e das características do seu habitat.

Records of Pere David´s Owl in China, 1869-2017 (literature and internet searches)						
YEAR	PROVINCE	LOCATION	SPECIMEN	PHOTO / SOUND	OBSERVA-TION	SOURCE / AUTHOR
1869	Sichuan	Moupin	•			A. David
1914	Sichuan	Hwanglunszhe	•			H. Weigold
1931	Sichuan	Red Basin	•			F. Smith
1985 ?	Gansu-S	Lianhuashan	•			students at field studies
1995	Gansu-S	Lianhuashan		•		W. Scherzinger
2006	Gansu-S	Lianhuashan		•		Yun Fang
2013	Gansu-S	Lianhuashan		•		Li Linxia
1999	Sichuan	Jiuzhaigou		•		F. Lambert
2006	Sichuan	Jiuzhaigou		•		W. Scherzinger
2006	Sichuan	Jiuzhaigou		•		Luopingzhou
2006	Sichuan			•		Demeulenmeester
2008	Sichuan			•		Demeulenmeester
2010	Sichuan-NW	Baxi		•		M. Francis
2010	Sichuan	Baxi		•		M. Francis
2011	Sichuan-N	Jiuzhaigou		•		J. Eaton
2012	Sichuan-NW	Baxi		•		M. Francis
2012	Sichuan-N			•		J. Wu
2013	Sichuan	Jiuzhaigou		•		E. Hui
2013	Sichuan	Gonggangling		•		Zoothera Birding
2013	Sichuan	Jiuzhaigou		•		D. Shapiro
2014	Sichuan-N			•		S. Wong
2015	Sichuan	Jiuzhaigou		•		Flora-Fauna-Field-Tours
2015	Sichuan			•		D. Lopez
2015	Sichuan			•		K. & L. Youngs
2015	Sichuan-N	Yalan		•		J. Eaton

Records of Pere David´s Owl in China, 1869-2017 (literature and internet searches)						
YEAR	PROVINCE	LOCATION	SPECIMEN	PHOTO / SOUND	OBSERVA-TION	SOURCE / AUTHOR
2015	Sichuan	Gongganglin g		•		J. Lee
2016	Sichuan	Gongganglin g		•		J. Tang
2016	Sichuan-NW	Linzhi		•		Y-H. Sun
2017	Sichuan			•		Zoothera Birding
2017	Sichuan	Gongganglin g		•		Rockjumper Birding Tours
	Sichuan	Gouwa		•		Y. Muzika
	Sichuan			•		B. Demeulenmeester
	Sichuan			•		R. McIntyre
	Sichuan			•		China Wild Tour
2005	Sichuan	Wawushan			•	Ch. Artuso
2010	Sichuan	Emeishan			•	Victor Emanuel Venture Tours
2015	Sichuan	Ruoergai			•	P. Hottala
2017	Sichuan	Gongganglin g			•	H. Laussmann & I. Kuehn
2017	Sichuan	Gongganglin g			•	North Thailand Birding
2017	Sichuan	Jiuzhaigou			•	P. Holt & Q. Wang
2017	Sichuan	Jiuzhaigou			•	M. Nelson, Birdtour Asia
2017	Sichuan				•	Ch. Hesse, Tropical Birding

Discussion

Specification of Pere David's Owl's taxonomic status

The overall appearance of *Strix davidi* clearly resembles the shape and size of Ural Owls (*Strix uralensis*), and therefore this Asiatic wood-owl was broadly accepted as a dark and big subspecies of the latter in former times (e.g., Stresemann 1923, Vaurie 1965, Eck & Busse 1973, Glutz & Bauer 1980. Scherzinger & Fang 2006). Due to the huge distribution area of the Ural Owl – from Japanese islands to northern Europe – the diverse subspecies developed a broad differentiation in size, basic colour and pattern of plumage: with small and reddish representatives in southern Japan, nearly black or dark brown to light brownish birds in the Balkans (SE-Europe), light grey owls in Fennoscandia and silvery-white exemplars in Siberia (illustrations by Weick, in Scherzinger et al. 2014). In consequence, the colour and pattern of plumage conform in many details between these two species: dark backside, V-shaped eye-brows, pinkish eyelids, vertical streaks on breast and flanks, row of white dots on shoulder (scapulars), furry feathers on tarsi, pearl-spotted rim of facial disc etc. (Tab. 6). But the plain and unicoloured central tail feathers and a black superciliar stripe are really unique characters of Pere David's owl.

A similar pattern of concordance was found in the vocal inventories of *Strix uralensis* and *Strix davidi*, although the analysis of vocalization may be preliminary in the latter. Interspecific comparisons in Tab. 7 point to a high degree of overlap: e.g., the character of

Table 6 - Simplified tabulation of characteristics of Pere David´s owls plumage, in comparison to typical features of Ural Owls. Due to a broad variability of colours and patterns within the eight accepted subspecies of *Strix uralensis*, there is a large overlap in detailed characteristics. But the dark brown, uniform and plain central tail-feathers are a species-specific character of *Strix davidi*.

Tabela 6 - Lista simplificada das características da plumagem da coruja de Sichuan, em comparação com as características típicas da coruja dos Urales. Devido a uma grande variação das tonalidades e padrões dentro de oito subespécies de *Strix uralensis* reconhecidas, existe uma grande sobreposição nestas características. O padrão característico de *Strix davidi* corresponde à presença de retrizes centrais lisas com coloração uniforme castanho-escura.

Which characters of plumage are significant and specific for Pere David´s Owl ?										
		Strix davidi	*Strix uralensis*							
CHARACTERISTICS	OF PLUMAGE		fuscescens	hondoensis	japonica	nikolskii	yenisseensis	uralensis	liturata	macroura
basic colour, breast a. flanks	whitish light				•			•		
basic colour, breast a. flanks	off-white	•		•	•	•	•	•	•	•
basic colour, breast a. flanks	light grey	•		•		•	•	•	•	•
basic colour, breast a. flanks	greyish brown			•		•	•		•	•
basic colour, breast a. flanks	yellowish brown		•						•	•
basic colour, breast a. flanks	pale tawny brown		•							•
basic colour, breast a. flanks	dark brown		•				•			•
eye-brows	V-shaped	•	•	•	•	•	•	•	•	•
vibrissae	A-shaped	•	•	•	•	•	•	•	•	•
accentuaton of eyes	pinkish eyelids	•	•	•	•	•	•	•	•	•
plumage on breast and flanks	vertical streakes	•	•	•		•	•		•	•
central tail feathers	long and wedged	•	•	•	•	•	•	•	•	•
shoulder (scapulars)	row of white spots	•	•	•	•	•			•	•
accentuaton of eyes	white half-moons	•	•	•	•	•	•	•	•	
beside the beak	white half-moons	•	•	•	•	•	•	•	•	•
tarsi and toes	furry plumage	•		•	•	•	•	•	•	•
rim of facial disc	pearl-spotted	•	•	•	•	•	•	•	•	•
design of facial disc	radial streaks	•	•	•	•	•	•	•	•	•
white pattern on forehead	V-shaped	•	•	•	•	•	•		•	•
wing (secundaries)	row of white spots	•	•	•	•	•		•	•	•
backside and mantle	dark-brown	•	•	•						•
accentuaton of eyes	black superciliar	•	•	•	•			•	•	•
central tail feathers	plain, unicolour	•	•							
backside and mantle	coarse mottled	•			•	•	•	•	•	•
plumage on breast and flanks	pale bars across	•	•	•	•					•

Which characters of plumage are significant and specific for Pere David´s Owl ?										
		Strix davidi	*Strix uralensis*							
CHARACTERISTICS	OF PLUMAGE		*fuscescens*	*hondoensis*	*japonica*	*nikolskii*	*yenisseensis*	*uralensis*	*liturata*	*macroura*
plumage on breast and flanks	strong arrowy	•	•							•
design of facial disc	concentric dots	•								•
central tail feathers	scribbled, patchy	•								
central tail feathers	markedly barred		•	•	•	•	•	•	•	•
plumage on breast and flanks	thin vertical lines				•			•		
tarsi and toes	thin bristled		•			•				

Figure 9 - All descriptions of *Strix davidi* in literature (by Sharpe 1875 and Stresemann 1923) are based on male specimens. Therefore the central "uniform coloured" tail feathers got a species specific character, and the main difference to the divers subspecies of *Strix uralensis*. (But a sexual dimorphism is supposable, as females show some dots and bars in the tail? Left: male in flight. Right: female specimen).

Figura 9 - Todas as descrições de *Strix davidi* na literatura (por Sharpe 1875 e Stresemann 1923) são baseadas em espécimes do sexo masculino. Consequentemente, a presença de retrizes centrais lisas com coloração uniforme castanho-escura foi assumido como a principal distinção relativamente às diversas subespécies de *Strix uralensis*. (Contudo, é possível que ocorra dimorfismo sexual, uma vez que as fêmeas apresentam algumas pintas e barras na cauda. Esquerda: macho em voo. Direita: espécime fêmea.).

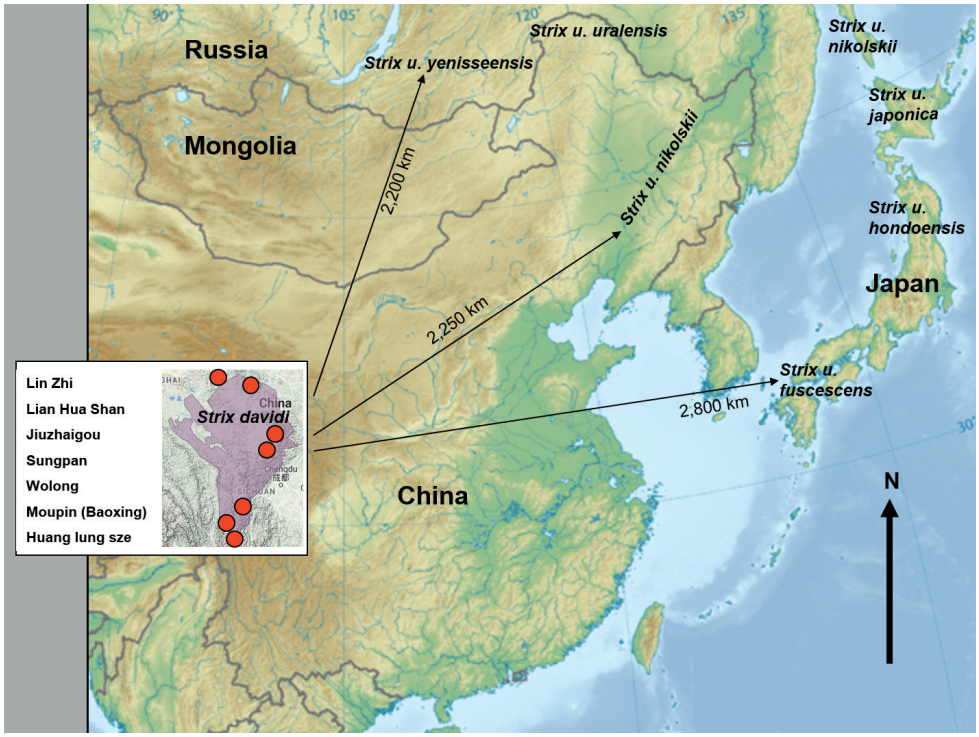
Table 7 - Comparisons of vocal utterances show a broad overlap in the inventories of *Strix davidi* and *Strix uralensis*, as songs, begging-, alarm-, and feeding notes resemble each other in rhythm, acoustic colour and meaning.

Tabela 7 - A comparação de vocalizações mostra uma grande sobreposição entre os repertórios de *Strix davidi* e *Strix uralensis*, uma vez que o canto e as vocalizações de pedido de alimento, alarme e alimentação se assemelham em termos de ritmo, timbre e significado.

Vocal inventory of *Strix davidi* (preliminary analysis)			*Strix uralensis*
JUVENILE	FEMALE	MALE	JUV. + FEMALE + MALE
	territorial song	territorial song	territorial song
		introductory syllables	introductory syllables
		introd. syllables + stutter	
		variable combinations (song + scale)	
		finishing syllabels	finishing syllabels
		soft song	soft song
	feeding stimulation		feeding stimulation
	low "bwuhh"	attracting low "moo"	
	nestsite demonstration	nestsite demonstration	nestsite demonstration
	aggressive scale	aggressive scale	aggressive scale
		copula twitter	copula twitter
	contact note (*kjwäk*)	contact note (*kjwäk*) ?	contact note (*kjwäk*)
	"begging" (*kjuwäk*)		"begging" (*kjuwäk*)
		extended alarm (?) call	extended alarm (?) call
	arousal note (*kuja*)		
	arousal note "barking"		
			long range "barking"
	arousal (*kuwack, guo*)		arousal (*kuwack, guo*)
begging (*kschjitt*)			begging (*kschjitt*)
moaning			moaning
shivering			shivering
bill snapping	bill snapping	bill snapping	bill snapping

Figure 10 - The map of eastern Asia clearly shows the small area of *Strix davidi* distribution in the mountainous forests of central China, limited by the Himalayan mountains in the west, the Gobi desert to the north, an arid semi-desert to the east, and the subtropical forest to the south. (Dots correlate with the records of this owl from the literature, internet and our observations.) The high degree of isolation from distribution areas of neighbouring subspecies of *Strix uralensis* justifies the ranking of *Strix davidi* as a discrete species. Map from wikimedia: East Asia topographic map.org.

Figura 10 - O mapa da Ásia oriental mostra claramente a pequena área de distribuição de *Strix davidi* nas florestas montanhosas da China central, limitada pelos Himalaias a oeste, pelo deserto de Gobi a norte, por um semideserto árido a este e pela floresta subtropical a sul. (Os pontos representam registos desta coruja descritos na literatura, online e observações deste estudo.) O elevado grau de isolamento relativamente às áreas de distribuição de subespécies vizinhas de *Strix uralensis* justifica a classificação de *Strix davidi* como uma outra espécie. Mapa retirado de wikimedia: East Asia topographic map.org.



male's territorial song (and its soft version), a soft ascending scale for "nest site demonstration" in both sexes, copula twitter of the male, females' contact note, begging and stuttering trill (to stimulate nestlings while feeding), harsh notes of arousal and alarm. But a low pitched mooing (both sexes) and variable utterances of arousal are unique in the Asiatic wood-owl. The main utterances of nestlings sound widely identical between these both species.

Despite the high degree of correspondence in detailed characters, the status of Pere David's Owl as a discrete species is broadly accepted nowadays (e.g., Mikkola 2012, Global Owl Project 2013). The justification is based in the long geographic isolation of *Strix davidi*, with a distribution strictly-limited to the old coniferous forest in the high mountains of central China and eastern Tibet, respectively. Bordered by the high mountains of Himalaya in the west, by the Gobi desert in the north, by an extensive man-made steppe in the east and the transition to subtropical forests in the south, the distances to neighbouring populations of *Strix uralensis* are minimally 2,200 km (to *Strix u. yenisseensis* and *nikolskii*), but 2,800 km to *Strix u. fuscescens* on the southernmost island of

Japan, which was suggested as closely related in former times (Fig. 9). Therefore *Strix davidi* counts as a rare endemic bird of central China (red List of China). But the former recommendation by Eck (1971) to merge *Strix uralensis* and *Strix davidi* as a super-species seems to fit best with the biological relatedness.

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Source of photos in Table 5-a, 5-b

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