Insights into the Natural History of *Pipistrellus endoi* Imaizumi, 1959 from Survey Records in Miyagi Prefecture

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Abstract: Assessing and documenting wildlife occurrence in a local area is important for the understanding of its natural history, being the latter a necessary condition to address conservation strategies and environmentally educate the local population. Records of the Japanese endemic bat *Pipistrellus endoi* are very limited all over Japan, a major reason why there has not been a conservation strategy for the species. In this paper, records of this bat from Miyagi Prefecture have been compiled, providing new insights into the ecology and natural history of *Pipistrellus endoi*.

Key words: bat, *Pipistrellus endoi*, hibernating site, litter size

1. Introduction

In Miyagi Prefecture, 15 species of bats have been reported (Table 1) (Akiba et al., 1966; Myagi Prefecture, 2013; O. Takahashi, unpublished data). The Red List of Miyagi Prefecture listed 9 out of these 15 species as data deficient (DD), VU (vulnerable), and CR+EN (critically endangered + endangered) (Table 1).

Table 1. List of bats and their Red List category in Miyagi prefecture.

	Category of the Red list*	
Species	Miyagi Prefecture 2013	Ministry of Environment 2012
Rhinolophus ferrumequinum		
Rhinolophus cornutus		
Nyctalus aviator	VU	VU
Pipistrellus abramus		
Pipistrellus endoi	CR+EN	VU
Barbastella leucomelas	DD	LP
Plecotus sacrimontis	VU	
Vespertilio sinensis		
Myotis frater	CR+EN	
Myotis ikonnikovi	VU	
Myotis macrodactylus		
Myotis pruinosus		VU
Miniopterus fuliginosus		
Murina hilgendorfi	VU	
Murina ussuriensis	VU	

*DD: data deficient, VU: (vulnerable) , CR+EN: critically endangered + endangered, LP: threatened local population

Pipistrellus endoi is an endemic species to Japan. The type locality is Horobe, Ashiro-cho, Ninohe, Iwate prefecture (Imaizumi, 1959). This species has been recorded from 16 prefectures in Japan (Kawai, 2009; see Fig. 1). However, the records of this species are

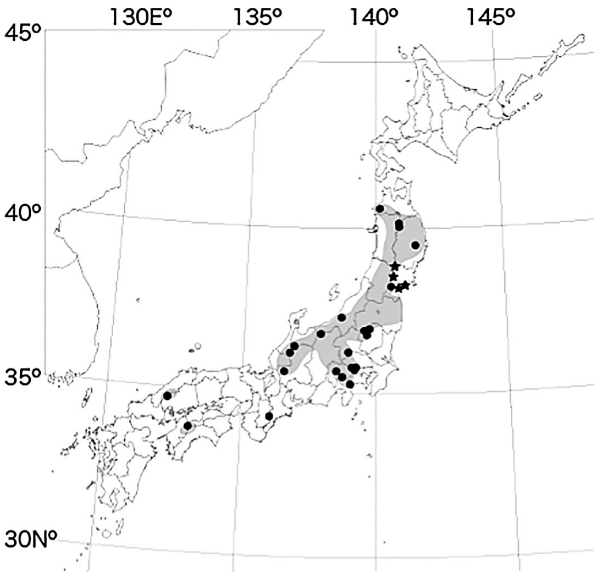

Fig. 1 Distribution map of *Pipistrellus endoi* Imaizumi, 1959 modified from Kawai, 2009.
The solid circles in the map denote the sites where this species was observed in Japan. Star shape shows new record sites in this study.

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very limited and only about 40 individuals have been reported. This species is not known from Kyushu, the Ryukyu archipelago, Hokkaido and many oceanic islands of the Japanese archipelago. In Miyagi Prefecture, the species has categorized as CR+EN due to very limited information and poor capture record.

The morphology of this species is similar to the *P. abramus*. But the baculum of *P. endoi* is apparently different from that of *P. abramus*: relatively short and neary straight, its straight-line length is 9-10 mm (Imaizumi, 1959). Little is known about the ecological features and its habitat, home range and behavior.

To elucidate the natural history of *P. endoi* in Miyagi Prefecture, we compiled all records of the species reported for the prefecture, and discuss the ecological features learnt from this data.

2. Methods

One of us, O. Takahashi, has conducted bat surveys in Miyagi Prefecture since 1990s. In this study, we compiled all records *P. endoi* from his field note to look for patterns that can help us understand the species ecology.

3. Results and discussion

We confirmed a total of 21 individuals of *P. endoi* from 7 sites in Miyagi Prefecture (Table. 2; Fig. 2). Of these, 6 were females: mean ± standard division (min-max); body weight (g) 7.5 ± 0.92 (6.8-8.7), forearm length (mm) 32.6 ± 0.58 (32.1-33.7); and 15 were males: BW 6.4 ±

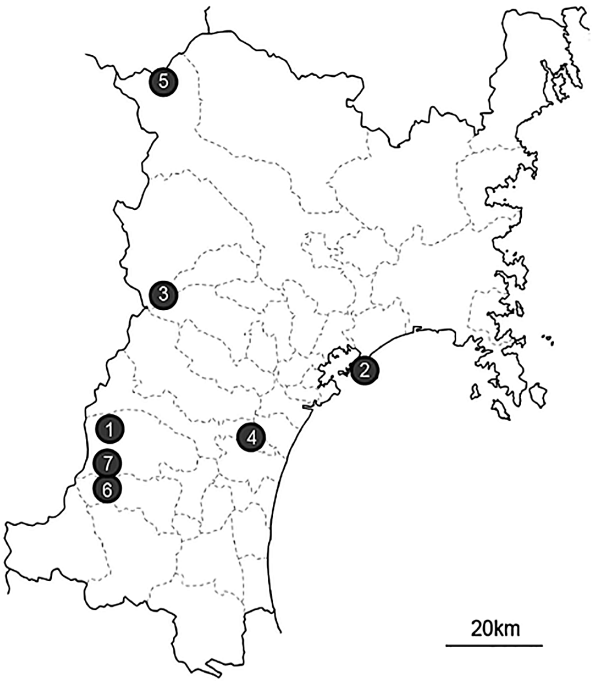

Fig. 2. Map of the sites where *Pipistrellus endoi* was confirmed.
The numbers correspond to Table 2.

Table 2. Body weight and forearm length measurement of bats in Miyagi Prefecture.

Date	Ring number	Sex	BW(g)	FA(mm)		Locality information			
						Locality* number	Mesh** code	Altitude (m)	Locality Name
19900905	—+	M	6.0	31.0	flying in the daytime	1	5740-2454	340	Imashuku Nanori, Kawasaki, Shibata
20030215	S2947	M	6.9	30.9	hibernating in crevice at stone pit	2	5741-4112	8	Miyato Island, Higashimatushima
20031124	S2942	F	8.7	32.2	hibernating in crevice at stone pit	2	5741-4112	8	Miyato Island, Higashimatushima
20040326	S2698	F	6.8	32.1	hibernating in crevice at stone pit	2	5741-4112	8	Miyato Island, Higashimatushima
20050812-13	NCN370	M	6.0	31.8	captured by harptrap	3	5740-5541	1020	Start point of a trail up Funagatayama Mt., Shikama, Kami
20061010-11	NCN486	M	5.8	33.3	captured by harptrap	4	5740-2674	200	Shrine at Taihaku-san, Taihaku, Sendai
20061103	NCN489	M	8.7	31.8	hibernating in crevice at stone pit	2	5741-4112	8	Miyato Island, Higashimatushima
20061103	NCN490	F	8.6	33.7	hibernating in crevice at stone pit	2	5741-4112	8	Miyato Island, Higashimatushima
20070227	NCN494	M	6.0	32.7	hibernating in crevice at stone pit	2	5741-4112	8	Miyato Island, Higashimatushima
20070602-03	NCN576	M	5.6	31.8	captured by harptrap	3	5740-5541	1020	Start point of a trail up Funagatayama Mt., Shikama, Kami
20100328	NCF1453++	M	5.6	30.8	hibernating in crevice at stone pit	2	5741-4112	8	Miyato Island, Higashimatushima
20100710-11	NCS680	M	6.2	31.3	captured by harptrap	5	5740-1451	580	Sankai-taki, Zao, Katta
20110611-12	NCF1472	F	7.0	32.3	captured by harptrap	6	5840-2520	460	Sukanedake forest road, Onikobe, Naruko onsen, Osaki
20120801-02	—	F	6.8	32.6	captured by harptrap	7	5740-1843	360	Aone dam, Kawasaki, Shibata
20120801-02	—	F	6.9	32.6	captured by harptrap	7	5740-1843	360	Aone dam, Kawasaki, Shibata
20120820-21	—	M	6.8	32.8	captured by harptrap	7	5740-1843	360	Aone dam, Kawasaki, Shibata
20130214	NCT401	M	6.4	31.4	hibernating in crevice at stone pit	2	5741-4122	4	Miyato Island, Higashimatushima
20140130	NCT410	M	6.7	32.4	hibernating in crevice at stone pit	2	5741-4122	8	Miyato Island, Higashimatushima
20141220	NCT430	M	6.6	31.1	hibernating in crevice at stone pit	2	5741-4122	4	Miyato Island, Higashimatushima
20141220	NCT431	M	6.6	34.2	hibernating in crevice at stone pit	2	5741-4122	4	Miyato Island, Higashimatushima
20150131	NCT435	M	6.5	32.9	hibernating in crevice at stone pit	2	5741-4122	4	Miyato Island, Higashimatushima

* The mumbers are correspondign to Fig. 2

** The mesh code indicate the locality on third-order map published by Ministry of Environment of Japan.

+ The specimen was donated to Dr.Yoshinori Imaizumi.

++ Hibernating with a cluster of 5 individuals of *Vespertilio sinensis* in the same slit.

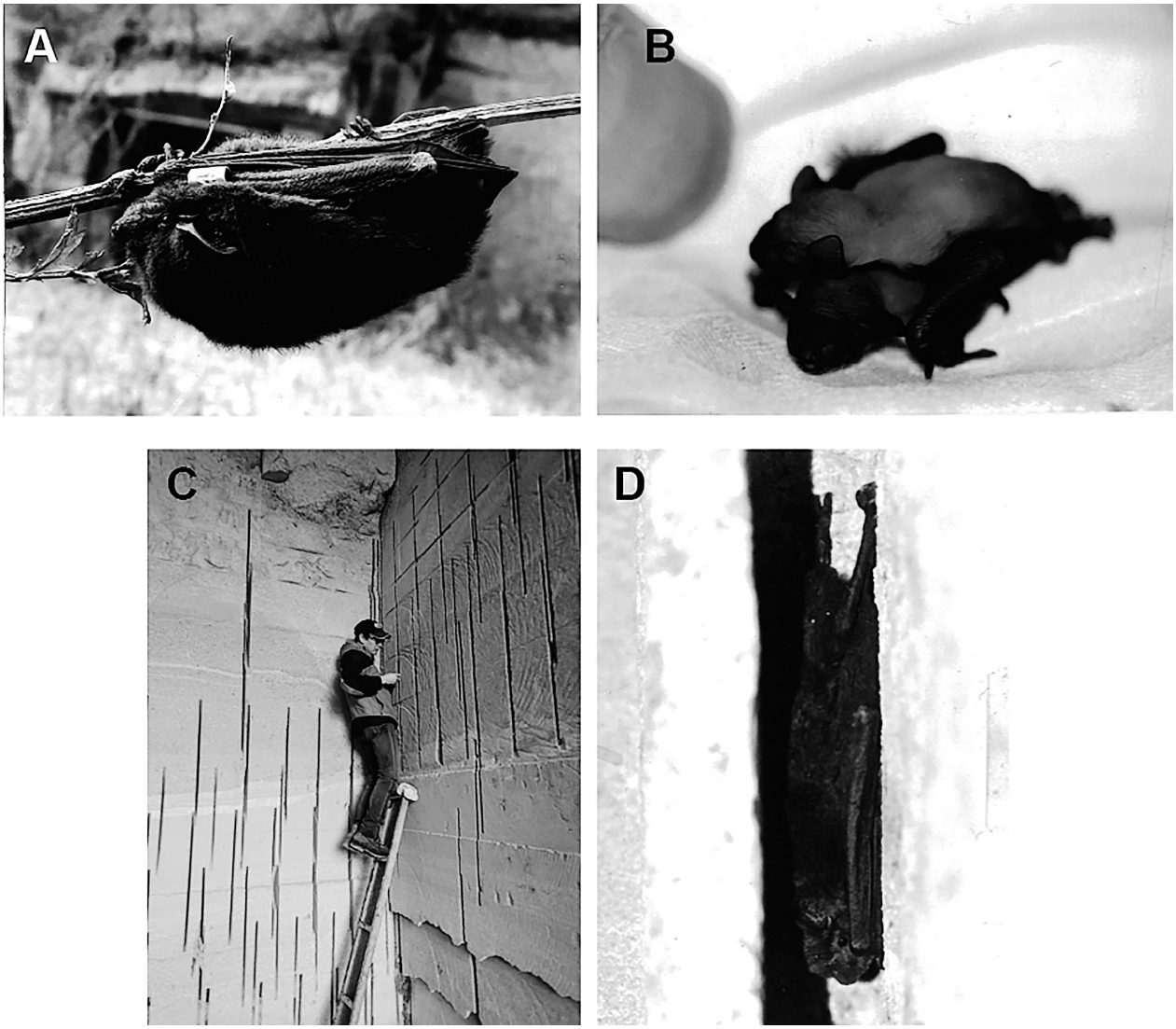

Fig. 3. Pictures of *Pipistrellus endoi* and the industrial stone pit where it hibernates in Miyagi Prefecture.
A: An individual of *P. endoi*, B: The two infants from a captive female, C: Hibernating *P. endoi* individuals carefully pulled out of the crevices, D: The stone pit and a hibernating bat.

0.76 (5.6-8.7), FA 32.0 ± 1.00 (30.8-34.2). Although most individuals of this species had been captured in the forest, only 8 individuals of those reported here for Miyagi prefecture had been captured in this kind of habitat (5 males and 3 females), at altitudes ranging from 360 to 1020 m. This species has been regarded as a forest dwelling bat given that it usually found in natural forests (Kawai, 2009), although there is a record from a secondary forest in suburban Tokyo (Kasahi et al., 2006). A similar record from a secondary forest, consisting mainly of Japanese cedar (*Cryptomeria japonica*), has been reported for Miyagi Prefecture (locality 4). Usually this species has been recorded from forests at altitudes over 1000 m (Abe et al., 1970; Yasui and Kamijo, 1990; Maeda, 1991; Ueno, 1993; Yamamoto et al., 2005; Ueno et al., 2002), and in fewer occasions from altitudes lower than 500 m (Suzuki, 1978; Machida et al., 1986; Urano, 1998; Kasahi et al., 2006). On the contrary, in Miyagi prefecture, records from 4 sites are in forests at altitudes lower than 500 m, and 2 above that (locality 3 and 5).

Information about the hibernating habits of *P. endoi* is extremely scarce. Only one record exist of a bat hibernating in a Japanese cedar at a forest in January (Yoshiyuki, 1990). However, in Miyagi Prefecture, 12 out of 21 records (9 males and 3 females) were of individuals captured when hibernating in solitary from November to

late March in rock crevices at an industrial stone pit (Fig. 3C, D). The stone pit is located in Miyato-jima Island, Higashi-matsushima city, at an altitude of 4 to 8 m above sea level. Moreover, the site where these individuals were captured far from any pristine forest, in a patchy landscape composed of rice field, sub-urban settlements and occasional secondary forests. This suggest that rock crevices are an important place for this species to hibernate, and that *P. endoi* may use different kinds of environments along the year, including anthropized ones as does its congeneric species *P. abramus*. These data points towards the need to establish a monitoring study of this site and similar ones common in Higashi-matsushima, to find he extend of rock crevices use as a hibernating site by this species, and advocate for the protection of the most important sites from further development.

One female (S2698) captured at the stone pit was injured by the survey, and it was kept from 26th March 2004 to July 2004. The female had two infants, male and female (Fig. 3B). The parturition occurred on June 18th, 2004. One of the infants (a female) was kept until October 21st, 2008 (four years and four months). It is known that the reproductive strategy for this species is the delayed fertilization type (Son et al., 1988). However, up to now, there was no information on litter size. This is the first report of litter size for *P. endoi*. Similarly, the parturition time had been assumed to be between mid-July to mid-August based on a few observations: lactating females have been captured in late July in Ishikawa Prefecture (Yamamoto et al., 2005), and early August in Aomori Prefecture (Machida et al., 1986). Our data shows that the parturition time in *P. endoi* can start at least a month earlier than previously reported, although this can also be the result of a better nutritional condition for the mother given that it was fed in captivity. However, although it is clear that its condition in captivity was different from that in the wild, mating probably occurred before March.

4. Conclusion

The records of *P. endoi* in Miyagi prefecture are very important for knowing the species' ecological requirements. Compiling the available data was key in elucidating two relevant elements when considering a conservation strategy: hibernating habits (preference for rock crevices), and litter size. This information, albeit still very poor, considerably advances what is known of *P. endoi*, and highlight the importance of surveying areas where endangered bats such as this can find refuge. The industrial stone pit where *P. endoi* has been found is at the moment an abandoned site with no ongoing human activities. However, as of this moment, there is no guarantee that this will not change in the future. Therefore, educating the local communities surrounding this locality is of importance to preserve the only known site in Japan where *P. endoi* hibernates outside its typical forest habitat. It is recommended that a monitoring program be implemented in this area so as to collect more data that could help us understand the natural history of this bat, and then apply this knowledge in environmental education activities where local people play a central role.

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