

BREEDING OF SWINHOE'S STORM-PETREL *OCEANODROMA MONORHIS* IN THE KUTSUJIMA ISLANDS, KYOTO, JAPAN

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Breeding of Swinhoe's Storm-Petrel *Oceanodroma monorhis* is only known on coastal islands in Japan, Korea, far-east Russia and China (Lee & Won 1988, Sato 1996, Kondratyev *et al.* 2000). Global population estimates range from 30000 individuals (Boersma & Groom 1993) to 100000 pairs (Birdlife International 2009), far fewer than the closely related Leach's Storm-Petrel *Oceanodroma leucorhoa* (Boersma & Groom 1993). Most reports of *O. monorhis* are from observations or captures of birds outside breeding areas (Bailey *et al.* 1968, James & Robertson 1985, Bretagnolle *et al.* 1991, Cubitt 1995), whereas studies of the breeding biology of this species are very limited (Won & Lee 1986, Lee & Won 1988). In addition to having a limited population, some colonies of *O. monorhis* are threatened by human activities and introduced predators. Although several colonies are known to be active in Japan, most contain only small numbers of individuals (Sato 1996). Yoshida (1981) noted breeding of Swinhoe's Storm-Petrel on the Kutsujima Islands, Kyoto, Japan, but details of this colony had remained unexamined. Because the size of the Kutsujima Islands suggested the possibility of a large breeding population, we surveyed the colony and estimated the size of the breeding population.

The Kutsujima Islands (35°43'N, 135°26'E) are located in the Sea of Japan, 25 km north of the port city of Maizuru in Kyoto, Japan (Figs. 1, 2). The islands are composed of two rocky islets, surrounded by steep rocky cliffs. They extend 650 m from north to south, and their maximum width is approximately 150 m. The highest points are 89 m and 74 m above sea level on the north and south islets,



Fig. 1. Breeding areas of Swinhoe's Storm-Petrels in Japan.

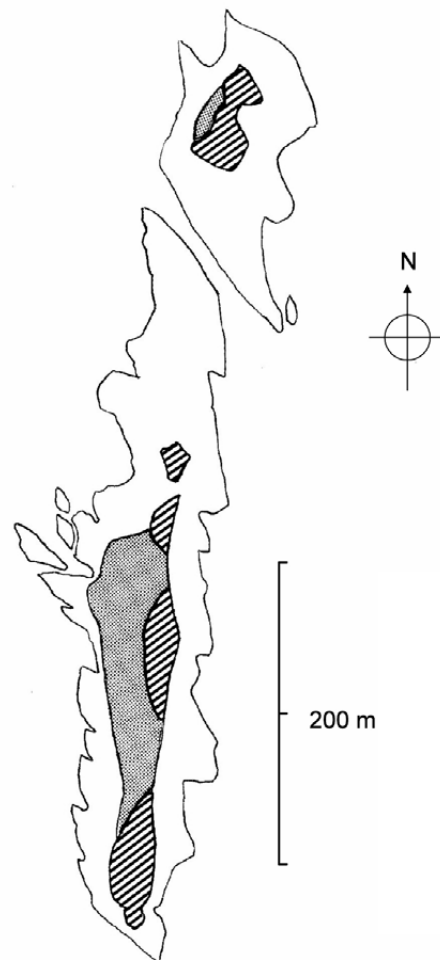


Fig. 2. Map of the Kutsujima Islands, prepared from an aerial photograph, showing approximate size and shape of the islands. Hatched areas are evergreen forests; shading depicts grassland. Remaining surface consists of bare rocky areas.

respectively. Narrow ridges are covered by small forests, dominated by an evergreen tree species *Machilus thunbergii*; the forests are surrounded by grasslands. The Tsushima warm current flows nearby. The breeding of Swinhoe's Storm-Petrel on these islands was first noted in 1965 by Yoshida (1981). Three other colonial seabird species are known to breed on the Kutsujima Islands—Black-tailed Gulls *Larus crassirostris*, Streaked Shearwaters *Calonectris leucomelas* and Japanese Murrelets *Synthliboramphus wumizusume*. Kammurijima Island, about 4 km south of the Kutsujima Islands, is heavily colonized by the Streaked Shearwater (Yoshida 1981) but is not known to have any breeding Swinhoe's Storm-Petrels. Neither the Kutsujima Islands nor Kammurijima Island has any human inhabitants. Landing on these islands, except for research or religious purposes, is prohibited by local laws.

We surveyed the south islet of the Kutsujima Islands during the breeding season, on 25 August 2007 and 11 August 2008. Four small forests grow on the south islet, in the far northern, northern, central and southern areas (Fig. 2). The estimated number of nests was based on nest counts in sample plots set in the forests. The southern forest is dominated by *Machilus thunbergii*, but other evergreen trees, *Camellia japonica* and *Ilex integra*, also grow there. The central forest is also dominated by *M. thunbergii*. The far northern and northern forests were comparatively bushy, with small *M. thunbergii* trees mixed with a vine species, *Elaeagnus macrophyllus*. Vines made our nest survey difficult, and we could not set sample plots in the far northern forest. However, we were able to set a small sample plot in the northern forest. In all, we established one sample plot in each of three forest sections of the south islet and counted burrows in each plot (4 × 15 m–25 m; Table 1). The north islet of the Kutsujima Islands also has forest dominated by *M. thunbergii*, but we could not reach the area because of the steep cliffs that ring the islet. Therefore, the population of Swinhoe's Storm-Petrel on the north islet remains unstudied.

Nest burrows of Swinhoe's Storm-Petrel were found under the evergreen canopy on the ridge, but were not found in the grasslands, where root systems of the grasses may make digging burrows difficult. The forest floor had poor ground cover and a scattering of many small rocks. Petrel burrows were mainly found under these rocks and were easily distinguished from those of the Streaked Shearwater by their smaller size. The occupancy rate of the nests on

the south islet was not fully examined, however. In our preliminary survey during the breeding season of 2008, we found eggs, chicks or incubating birds in six out of 10 nest burrows. Assuming an occupancy rate of 60%, we estimated that there were 3 800 pairs on the south islet (Table 1). That figure may increase substantially when the north islet is surveyed. In contrast, the breeding population of Streaked Shearwaters on the Kutsujima Islands was very small (Table 1).

The breeding of Swinhoe's Storm-Petrel has long been noted in Japan (Kuroda 1922, Kumagai 1935, 1936; Fig. 1, Table 2), but there is recent concern about populations at historical breeding sites. Bentenjima Islet, Shiriyazaki, Aomori Prefecture, has been connected to the mainland for the mining of limestone, and breeding there is believed to have ceased. A recent survey of Oshima Island, Nanatsujima, Ishikawa Prefecture, found no sign of an active breeding population (Tachibana 1986). Hoshigamijima Island, Oki, Shimane Prefecture, may have a breeding population, but detailed surveys have not been conducted. Recent evidence of Swinhoe's Storm-Petrels breeding in Japan has been reported for only three areas outside of the Kutsujima Islands—Kojine Islet off Hachijo-kojima Island, Tokyo; Sanganjima Island, Iwate; and Koyashima Islet, Fukuoka. Observers estimated no more than 200 pairs colonizing in each area (Kumagai 1935, 1936, Sato 1996). Although large colonies of Leach's Storm-Petrel are known on Hokkaido, breeding of Swinhoe's Storm-Petrel on Hokkaido has not been documented (Osa & Watanuki 2002). Therefore, the total population of Swinhoe's Storm-Petrel in Japan is estimated to be <5 000 pairs, and the breeding colony on the Kutsujima Islands may be the largest.

The breeding population on the Verkhovsky Islands, off Vladivostok, Russia, is estimated to be 8 370 pairs, with an additional 100 pairs or fewer found on small islands nearby (Kondratyev *et al.* 2000). As many as 2 500 birds were ringed on Dagong Island off Qingdao, China (Cai 1998), where half of the birds released in one year were retrapped the following year. Although the details of the ringing were not described, we consider there are at least 5 000 individuals in that colony. In addition, it is estimated there are a minimum of 100 pairs at Wu Yu (Black Rock) off Nan'ao Island, Guangdong, China (Sibley *et al.* 1999), and approximately 7 900 to 11 890 pairs in the colony on Chilbal Island, southwest of the Korean Peninsula

TABLE 1
Estimated numbers of Swinhoe's Storm-Petrels and Streaked Shearwaters on the south islet, Kutsujima Islands, Japan

Observations	Forest area				Total
	South	Central	North	Far North	
Year examined	2008	2007	2008	not examined	
Estimated area of wood (m ²)	1 650	1 200	350	300	
Size of sample plot	4 m × 25 m	4 m × 20 m	4 m × 15 m		
Swinhoe's Storm-Petrel					
Nests in sample plot	163	236	14		
Estimated total nests	2 690	3 540	82		6 312
Streaked Shearwater					
Nests in sample plot	7	0	2		
Estimated total nests	116		12		128

(Lee & Won 1988, Taoka *et al.* 1989). Finally, it is estimated that there are as many as 112 600 pairs on Kugul Islet, Sohuksan Island, Korea (Won & Lee 1986). Although other Korean islands may have colonies of this species, information on population sizes is not available. Based on these surveys, we estimate there are a minimum of 130 000 pairs of Swinhoe's Storm-Petrel worldwide. However, that figure depends largely on the estimated breeding population on a single islet—Kugul Islet, Korea. More detailed surveys are needed to refine the estimate and to obtain information on population trends.

Some colonies of Swinhoe's Storm-Petrel are threatened by human activities, accidentally introduced predators, tourism and other factors. The breeding population on Verkhovsky Island is threatened by recreational visitors in warm seasons (Kondratyev *et al.* 2000), and Dagong Island is also visited by tourists. The colony on Koyashima Islet, Fukuoka, was decimated by accidentally introduced Norway Rats *Rattus norvegicus* (Takeishi 1987) and has not recovered fully, despite subsequent removal of the rats. Intense fishing occurs near the breeding areas of Swinhoe's Storm-Petrels, which likely results in occasional landing by fishermen and increases the risk of accidental introduction of rats to the breeding colonies. Although we found no evidence of rats on the Kutsujima Islands, and the possibility of their introduction seems low under current landing restrictions, small numbers of amateur fishermen may sometimes come ashore.

The Kutsujima Islands are rocky, and soil on the ridge appears shallow. If soil were lost during heavy rain or a typhoon, the colony could be seriously affected. Competition for nesting sites between Madeiran Storm-Petrels *Oceanodroma castro* and Streaked Shearwaters has been reported on Hide-shima Island, Iwate Prefecture (Sato & Tsurumi 2003). Competition with Swinhoe's Storm-Petrel does not seem to be an issue on the Kutsujima Islands, however, because the rocky forest floor is not suitable for digging large burrows, which the Streaked Shearwater requires. In contrast, nearby Kammurijima Island, with a wide, rock-free area under its *M. thunbergii* forest, is home to a large colony of Streaked Shearwaters.

Predation by Herring Gulls *Larus argentatus* is reported for Atlantic breeding colonies of Leach's Storm-Petrel (Stenhouse *et al.* 2000). Although the breeding seasons of Black-tailed Gulls and Swinhoe's Storm-Petrels overlap in the Kutsujima Islands, Storm-Petrel predation by this gull is not known.

Our study is the first to report details of a breeding colony of Swinhoe's Storm-Petrel in Japan. The breeding population on the Kutsujima Islands appears to be an important and sustainable one. The north islet of the Kutsujima Islands remains unexamined, however, and the occupancy rate of nest burrows needs more study. The trend of the breeding population should be carefully monitored, because the possibility of human disturbance in the colony or associated foraging areas cannot be excluded. Outside the Kutsujima Islands, Hoshigamijima Island, Oki, Shimane, may have a breeding colony of this species but remains unexamined. A survey of that island is needed to document further the breeding population of Swinhoe's Storm-Petrel in Japan.

REFERENCES

- BAILEY, R.S., POKLINGTON, R. & WILLIS, P.R. 1968. Storm-Petrels *Oceanodroma* spp. in the Indian Ocean. *Ibis* 110: 27–34.
- BIRDLIFE INTERNATIONAL. 2009. *Oceanodroma monorhis*. IUCN Red List of Threatened Species. Ver. 2009.2. [Available online at: www.iucnredlist.org; accessed 22 December 2009]
- BOERSMA, P.D. & GROOM, M.J. 1993. Conservation of storm-petrels in the North Pacific. In Vermeer, K., Briggs, K.T., Morgan, K.H. & Siegel-Causey, D. (Eds). The status, ecology and conservation of marine birds in North Pacific. Ottawa: Canadian Wildlife Service Special Publication. pp. 112–121.
- BRETAGNOLLE, V., CARRUTHERS, M., CUBITT, M., BIORET, F. & CUILLANDRE, J.-P. 1991. Six captures of a dark-rumped, fork-tailed storm-petrel in the northern Atlantic. *Ibis* 133: 351–356.
- CAI, Z.J. 1998. A study on breeding and migration of Swinhoe's Storm-Petrel [Chinese]. *Chinese Journal of Zoology* 33: 19–22.
- CUBITT, M.G. 1995. Swinhoe's Storm-Petrels at Tynemouth: new to Britain and Ireland. *British Birds* 88: 342–348.
- JAMES, P.C. & ROBERTSON, H.A. 1985. First record of Swinhoe's Storm-Petrel *Oceanodroma monorhis* in the Atlantic Ocean. *Ardea* 73: 105–106.
- KONDRATYEV, A.Y., LITVINENKO, N.M., SHIBAEV, Y.V., VYATKIN, P.S. & KONDRATYEVA, L.F. 2000. The breeding seabirds of the Russian Far East. In Kondratyev, A.Y., Litvinenko, N.M. & Kaiser, G.W. (Eds). Seabirds of the Russian Far East. Ottawa: Canadian Wildlife Service Special Publication. pp. 37–81.
- KUMAGAI, S. 1935. Swinhoe's Storm-Petrel in the Tohoku region [Japanese]. *Tori* 9: 239–241.

TABLE 2
Breeding areas of Swinhoe's Storm-Petrel reported in Japan

Island	Location	Prefecture	Latitude (N)	Longitude (E)	Recent status of breeding population	Population estimate (pairs)	Reference
Bentenjima	Shiriyazaki	Aomori	41°25'	141°26'	Probably extinct		Sato (1996)
Sanganjima	Kamaishi	Iwate	39°18'	141°59'	Active	≤200	Kumagai (1935)
Kojine	Hachijo-kojima	Tokyo	33°08'	139°42'	Active	≤200	Unpubl. data
Oshima	Nanatsujima	Ishikawa	37°37'	136°54'	Breeding unconfirmed		Tachibana (1986)
Hoshigamijima	Oki	Shimane	36°09'	133°04'	Probably active		Sato (1996)
Koyashima	Okinoshima	Fukuoka	34°14'	130°07'	Active	≤200	Takeishi (1987)
Kutsujima	Maizuru	Kyoto	35°43'	135°26'	Active	3 790	Current study

- KUMAGAI, S. 1936. On a new breeding site of storm-petrels in northern Japan [Japanese]. *Dobutsugaku Zasshi*. 48: 216–217.
- KURODA, N. 1922. Additional notes on the Japanese species of *Oceanodroma*. *Ibis* 64:437–440.
- LEE, K.S. & WON, P.O. 1988. Breeding biology of Swinhoe's fork-tailed petrel *Oceanodroma monorhis* (Swinhoe) on Chilbal Islet, Korea [Korean with English summary]. *Bulletin of the Korean Institute of Ornithology* 2: 39–60.
- OSA, Y. & WATANUKI, Y. 2002. Status of seabirds breeding in Hokkaido. *Journal of the Yamashina Institute for Ornithology* 33: 107–141.
- SATO, F. 1996. Swinhoe's Storm-Petrel. In Report on rare wild aquatic life III [Japanese]. Tokyo: Japan Fisheries Resource Conservation Association. pp. 477–481.
- SATO, F. & TSURUMI, M. 2003. Prevention of nest burrow destruction of the endangered Madeiran Storm-Petrel by Streaked Shearwaters using wire mesh netting [Japanese with English summary]. *Journal of the Yamashina Institute for Ornithology* 34: 325–330.
- SIBLEY, F., LU, W. & LAZELL, J. 1999. Swinhoe's Storm-Petrel, Bridled Tern, and Lesser Crested Tern at Wu Yu (Black Rock), Nan Ao county, Guangdong, China. *Waterbirds* 22: 142–144.
- STENHOUSE, I.J., ROBERTSON, G.J. & MONTEVECCHI, W.A. 2000. Herring Gull *Larus argentatus* predation on Leach's Storm-Petrels *Oceanodroma leucorhoa* breeding on Great Island, Newfoundland. *Atlantic Seabirds* 2: 35–44.
- TACHIBANA, E. 1986. Avifauna of the Nanatsujima Islands. In Environmental Division, Ishikawa Prefecture Government (Ed). Natural history of Hekurajima and Nanatsujima [Japanese]. pp. 87–90.
- TAKEISHI, M. 1987. The mass mortality of Japanese Murrelet *Synthliboramphus wumizusume* on the Koyashima Islet in Fukuoka [Japanese]. *Bulletin of Kitakyushu Museum of Natural History* 7: 121–131.
- TAOKA, M., WON, P.-O. & OKUMURA, H. 1989. Vocal behavior of Swinhoe's Storm-Petrel (*Oceanodroma monorhis*). *The Auk* 106: 471–474.
- WON, P.O. & LEE, H.S. 1986. The reproductive success of Swinhoe's Fork-tailed Petrel on Kugul Islet, Sohuksan Island, Korea [Korean with English summary]. Thesis. *Theses Collection, Kyung Hee University* 15: 15–27.
- YOSHIDA, N. 1981. Climbing seabird [Japanese]. Tokyo: Chobunsha. 304 pp.
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