

Ecological Notes on the Introduced Population of the Snake *Amphiesma vibakari* on Miyake-jima, the Izu Islands, Japan

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Abstract An insular population of the snake *Amphiesma vibakari* artificially introduced onto Miyake-jima, the Izu Islands was described for within island distribution, body size, intra-island distribution, body size, reproductive characteristics and diet. They settled down in the western half of the island by 1984. Captures of both gravid females and juveniles suggested establishment of *A. vibakari* population on Miyake-jima. Body size and clutch size (2-3) were both smaller than those in the nearest mainland. Egg mass (1.6 g) was, however, similar to that of the mainland population. Their diets consisted of juvenile *Eumeces okadae* and earthworm.

Key words: *Amphiesma vibakari*, island population, natural history.

The natricine snake, *Amphiesma vibakari*, is a semi-aquatic species feeding primarily upon amphibians, fresh-water fishes and earthworm (Fukada, 1959; Moriguchi and Naito, 1982). Nevertheless, some islands without such types of prey or suitable aquatic habitats are inhabited by this species (Aoki *et al.*, 1979; Ohno, 1969; Ota, 1983; Toriba, 1986). This fact suggests that the island populations of *A. vibakari* have been molded to cope with poor resources and habitat conditions (Ohno, 1969; Toriba, 1986). On the contrary, Sengoku (1979a) argued that *A. vibakari* is intrinsically a gifted inhabitant of islands, since this snake may have rather broad ecological requirements. Our knowledge of the ecology of insular *A. vibakari*, however, is so limited to some occasional observation (Aoki *et al.*, 1979; Ohno, 1969) that factors responsible for successful insular colonization remains to be determined.

Miyake-jima of the Izu Islands, formerly free from snakes, is now colonized by the artificially introduced *A. vibakari* (Sengoku, 1979b). The population of this island is of special interest, because it is likely to provide valuable data concerning ecological processes of an insular adaptation. During the long term field study of the skink *Eumeces okadae*, a total of 11 *A. vibakari* were collected. The present paper describes the habitat and distribution within the island, body size and reproductive characteristics of this species on the basis of these specimens. In addition, the nature of insular adaptation by *A. vibakari* was discussed in comparison with the mainland populations.

Materials and Methods

Field work was carried out on Miyake-jima (35°05' N, 130°30' E; 5514 ha in area), the Izu Islands. Forest vegetations are well developed under the mild climate with an annual mean air temperature being 17.6 °C and an annual rainfall reaching about 3000 mm (Japan Meteorological Agency, 1982). Despite such heavy rainfall, most aquatic habitats, e.g., water holes or streams, are ephemeral. The two volcanic lakes have permanent water, although one of the two (Shinmyo-ike) had destroyed after the volcanic eruption in October 1983. No amphibian is native to the island.

Snakes were collected from July 1977 to October 1984. The snakes were forced to regurgitate immediately after capture. Their stomach contents were identified to the lowest possible taxon. Snout-vent length (SVL) and tail length (TL) were measured to the nearest mm. Body mass was weighed to the nearest 0.1 g. The snakes with oviductal eggs were kept in the laboratory until egg-laying. Individual eggs were measured on their lengths and widths to the nearest 0.1 mm and weighed to the nearest 0.1 g.

Results

During the course of the field study from 1977 to 1984, a total of 11 *A. vibakari* was recorded (Table 1). Four of eleven snakes were the road-killed individuals, and the remaining seven were captured alive. Of the 7 live snakes, 2 were found

Table 1. Records of *Amphiesma vibakari* on Miyake-jima from 1978 to 1984.

| No. | Date | Locality | Sex | SVL (mm) | Tail L. (mm) | Body wt. (g) | Notes |
|-----|-------------|------------|--------|-------------|-----------------|-----------------|----------|
| 1 | 10 Aug. '78 | Tsubota | Juv. | 235 | 30+ | — | |
| 2 | 10 May '81 | Nippana | — | — | — | — | roadkill |
| 3 | 4 Oct. '81 | Shinmyo | male | 358 | 67+ | — | roadkill |
| 4 | 11 Jul. '82 | Shinmyo | female | 318 | 100 | 17.3 | gravid |
| 5 | 13 Jul. '82 | Shinmyo | female | 381 | 136 | 23.5 | gravid |
| 6 | 15 Oct. '82 | Tomoji | — | — | — | — | |
| 7 | 2 Jul. '83 | Anegawa | male | 386 | 138 | 22.4 | |
| 8 | 4 Jul. '83 | Anegawa | female | 306 | 97 | 16.4 | gravid |
| 9 | 4 Jun. '84 | Sabigahama | female | 372 | 141 | — | roadkill |
| 10 | 27 Jul. '84 | Tomoji | — | — | — | — | roadkill |
| 11 | 3 Aug. '84 | Tomoji | male | 368 | 101+ | 18.1 | |

crawling on the floor of the second growth forest of *Alnus sieboldiana* and 5 were under the rocks at the edge of the forest. The earliest appearance in the year was 10 May 1981 and the latest was 15 October 1982. Numbers of snakes found per day were 0.03 – 0.13 during the active season, with a peak in July.

Localities of *A. vibakari* concentrated primarily on the western half of the island (Nippana, Shinmyo, Sabigahama, Anegawa and Tomoji; see Table 1). This is consistent with information that *A. vibakari* was artificially released at Ako, the village located at the southwestern corner of the island (Asanuma, per. com.), suggesting that the range of distribution was expanding both north- and eastward from Ako.

Body sizes were measured for 8 individuals (Table.1). The mean SVL of females was 344.3 mm with a range of 306–381 mm SVL ($n=4$) and that of males was 370.6mm with a range of 358–386 mm ($n=3$). One apparently juvenile female was 235mm SVL.

Three females collected in July were all gravid and laid eggs in late July (Table.2). Clutch sizes were 2 ($n=1$) and 3 ($n=2$). The average egg mass was 1.56 g with an average size of 30.7mm (length) \times 8.5mm (width). The ratios of the clutch to body mass (excluding clutches) were 0.388–0.484 ($x=0.448$).

The diet was recorded from one out of 7 live snakes (14.3%). One earth-worm and a hatchling *Eumeces okadae* were found in its stomach.

Discussion

The distribution records of *A. vibakari* on the

Table 2. Reproductive data of *Amphiesma vibakari* from Miyake-jima. Body masses are those after egg layings. Mass=g, and length and width=mm.

| Indivi No. | Date of egg laying | Body mass | Clutch Size | Clutch mass | Egg measurements | | |
|---------------|-----------------------|--------------|----------------|----------------|------------------|--------|-------|
| | | | | | mass | length | width |
| 1 | 26 Jul. '82 | 7.9 | 3 | 3.82 | 1.27 | 27.8 | 8.1 |
| 2 | 26 Jul. '82 | 11.6 | 3 | 4.50 | 1.50 | 32.4 | 8.2 |
| 3 | 29 Jul. '83 | 8.1 | 2 | 3.83 | 1.91 | 31.9 | 9.1 |
| Pooled | | 9.2 | 2.7 | 4.05 | 1.56 | 30.7 | 8.5 |

amphibian-free islands are summarized in Table 3. *A. vibakari* is the only snake species on Hegura-jima (Ohno, 1969), O-shima of the Danjo Islands (Toriba, 1986) and Saru-shima in the Tokyo Bay (Aoki et al., 1979). Kanmuri-jima is the only amphibian-free island where *A. vibakari* coexisted with the other snake *Elaphe climacophora* (Ota, 1983). The diets of *E. climacophora* consist of warm-blooded vertebrates in gegenral and of small mammals on the islands in particular (Hasegawa and Moriguchi, 1989). These distribution records suggest that *A. vibakari* can persist on the islands without potential competitors. The colonization on Miyake-jima may have been successful, since the island had not been occupied by the other snake species.

The Miyake-jima population of *A. vibakari* can be contrasted with the mainland populations ecologically. In the central Honshu, *A. vibakari* is found mostly around the paddy fields and diets are earthwarms and aquatic animals like amphibian larvae and loaches (Moriguchi and Naito, 1982). Whereas, on Miyake-jima, it is semi-fossorial, living in the terrestrial habitats such as

Table 3. Summary of the distribution and body size of *Amphiesma vibakari* on some Japanese islands.

| Island | Area (ha) | max. SVL (mm) | N | Source |
|--------------------|-----------|---------------|-----|------------------|
| O-shima | 281 | 179 | 5 | Toriba 1986 |
| Danjo Is. | | | | |
| Samu-shima | 5 | 342 | 1 | Aoki et al. 1979 |
| Tokyo Bay | | | | |
| Kanmuri-jima | 23 | — | — | Ota 1983 |
| Hegura-jima | 115 | 350 | 1 | Tokumoto 1983 |
| Miyake-jima | 5514 | 386 | 8 | This study |
| mainland (Kyoto)* | | 479 | >10 | Fukada 1965 |
| mainland(Yokohama) | | 449 | 106 | Moriguchi 1989 |

*estimated from total length by the equation for SVL-total length relationship (Moriguchi 1989).

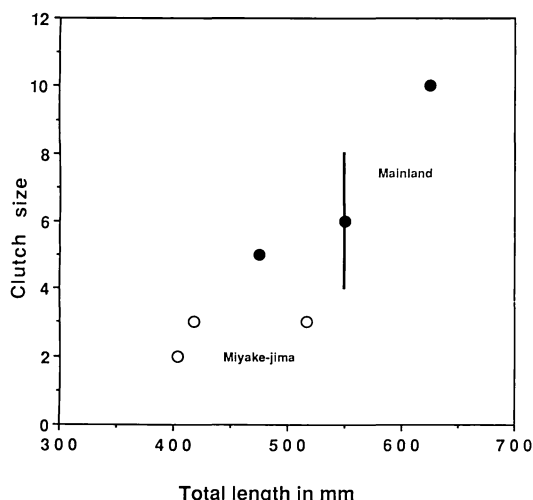


Fig. 1. The relationship between clutch size and total length in *Amphiesma vibakari* from Kyoto (solid circles) (Fukada, 1965), and Miyake-jima (open circles). Vertical bar indicates the range of clutch sizes at a total length class's of 500-600mm SVL.

forest floor. Absence of aquatic habitats with suitable prey may be responsible for this habitat shift, resulting in the shift of diets to strictly terrestrial prey. Semi-fossoriality was suggested to be related to foraging in the leaf litter (Toriba, 1986).

Island populations of snakes often differ from those of mainland relatives in the several life history traits (Shine, 1987). Body size and reproductive characteristics are often treated in recent studies of insular snake populations (Schwaner, 1985; Shine, 1987; King, 1986). *A. v. danjoensis* of

the Danjo Islands is characterized by its considerably small body size (Toriba, 1986). *A. vibakari* of the Miyake-jima and other islands are slightly smaller than that of the nearest mainland (Table 3). Clutch sizes (2-3) are apparently smaller in the Miyake-jima population compared with those of the mainland population (mean=6.4 with range of 4 - 10; Fukada, 1965). Since egg size is similar between the Miyake-jima (1.6 g) and the mainland (1.9 g), this small clutch size may be resulted from small body size of the females (Fig. 1).

The habitat shift, small body and clutch size of the Miyake-jima population seem to be phenotypic variations rather than adaptive response to the poor insular environment. This is probably because the population has not enough time to adapt to the insular environment, since its introduction to the island occurred 50 years ago at most (Asanuma, per. com.). In an evolutionary time scale, significant changes would appear in several life history traits (Schwaner, 1985). Nevertheless, evolutionary changes may not be similar to the phenotypic variations like those observed in this study. For example, both gigantic and dwarfed insular populations have diverged in several snake species (Schwaner, 1985; Hasegawa and Moriguchi, 1989). Therefore, further researches should be conducted for the native insular populations to clarify the pattern and nature of insular adaptation by *A. vibakari*.

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伊豆諸島三宅島に移入されたヒバカリの生態的特徴

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伊豆諸島の三宅島に人為的に移入されたヒバカリの生息状態を、1978年から1984年に採集された11個体に基づいて記載した。ヒバカリは、1984年までに島の西半分に分布域を広げていた。妊娠個体と幼体の採集によって、島への定着に成功していることが示唆された。三宅島の移入個体群は、本州の個体群と比較して、若干小型で一腹卵数が少なかったが、卵サイズに差はなかった。餌として、オカダトカゲの幼体とミミズが記録された。