

The Herpetofauna of the Senkaku Group, Ryukyu Archipelago¹

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ABSTRACT: The herpetofauna of the Senkaku Group, western Ryukyus, was reviewed on the basis of recent fieldwork, as well as museum specimens and literature records. As a result, six species of reptiles were recorded from the islands. They are *Gekko hokouensis* Pope, *Eumeces elegans* Boulenger, *Scincella* sp., *Ramphotyphlops braminus* (Daudin), *Elaphe carinata carinata* (Günther), and *Dinodon rufozonatus rufozonatus* (Cantor). No amphibian species were recorded. The herpetofauna of the Senkaku Group is distinct from that of other parts of the Ryukyu Archipelago and is more similar to that of Taiwan and eastern continental China. These conclusions conform with paleogeographical evidence indicating that most islands of the Senkaku Group and Taiwan were connected to the eastern margin of the continent during the most recent glacial period, when the remaining Ryukyu Islands were never connected by dry land with the continent.

THE SENKAKU GROUP consists of eight uninhabited islets, ca. 150 km NNW of the Yaeyama Group and ca. 160 km ENE of Taiwan (Figure 1). Unlike the other Ryukyu Islands, the Senkaku Group lies on the northwestern side of the Okinawa Trough (i.e., the southeastern margin of the East China Continental Shelf), thus having a unique geohistory (see Discussion for further details) and a fauna and flora distinct from that of the other Ryukyus.

Relatively few and mostly brief surveys have been made of the fauna and flora of the Senkaku Group (Kuroiwa 1900, Miyajima 1900, 1901, Masaki 1941, Takara 1954, Ikehara and Shimojana 1971). This neglect is chiefly due to the group's isolation and the

absence of regular transportation media from the other islands of the Ryukyu Archipelago. Moreover, although a comprehensive biological survey was made in 1979 by S. Ikehara and other colleagues, the results remain unpublished.

An opportunity permitted N.S. and S.I. to visit and to survey the herpetofauna of the four major islands of the Senkaku Group (see Figure 1) in May 1991. Here we review the herpetofauna of this island group on the basis of that collection as well as available museum specimens and literature reports.

Descriptions of the Islands

Uotsurijima (25° 45' N, 123° 28' E) is the largest island of the Senkaku Group, ca. 4.3 km² and 362.0 m maximum elevation. This island is composed mostly of sandstone beds surrounded by a narrow belt of upheaved coral reef along the coast. Inland water is limited to seven small springs and streams along the northern coast (Takara 1962, Kizaki 1985). Forests (chiefly of *Livistona chinensis* var. *subglobosa* [Hasskal] Beccari, *Arenga tremula* [Blanco] Beccari, *Ficus microcarpa* Linnaeus fil., and *Planchonella obovata* [Brown] Pierre) occupy most of the island except for the coastal area, where shrubs (e.g.,

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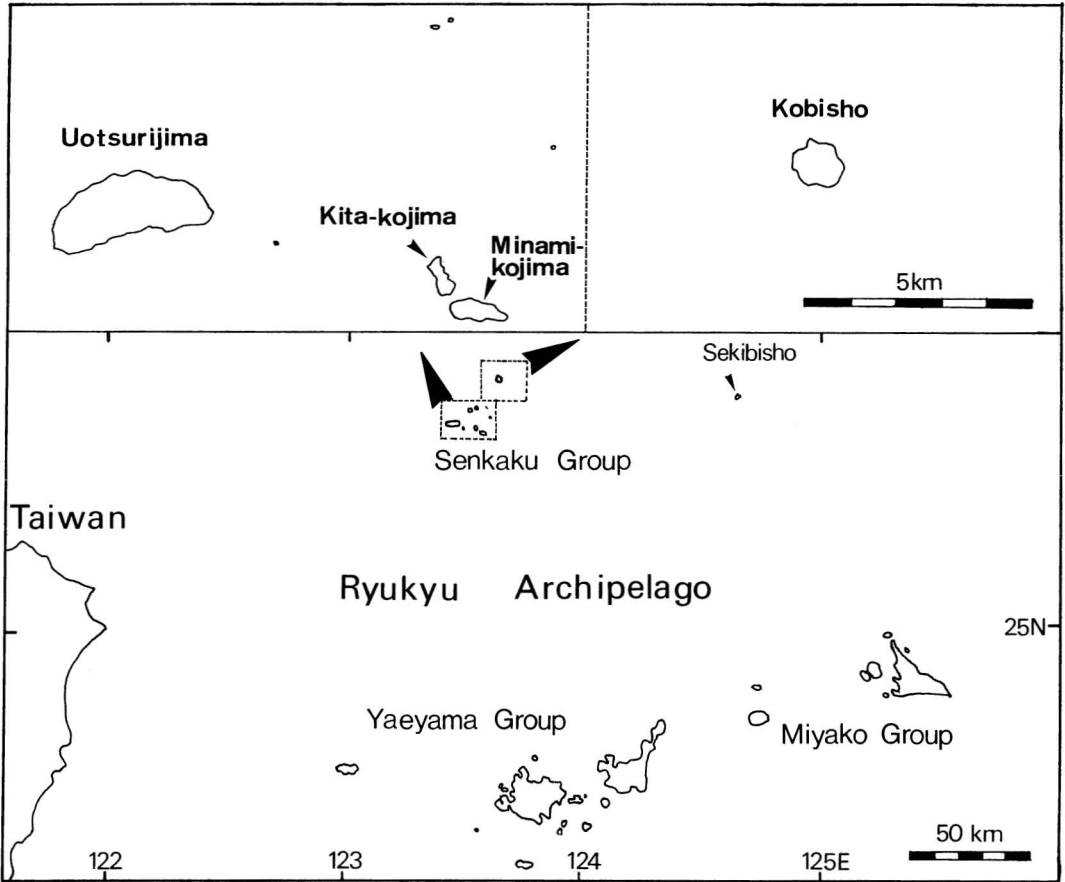


FIGURE 1. Map of southern Ryukyus and Taiwan, showing the location of the Senkaku Group.

Scaevola taccada [Gaertner] Roxburgh and *Argusia argentina* [Linnaeus fil.] Hein) dominate (Niiro 1964).

Kita-kojima ($25^{\circ} 42' N$, $123^{\circ} 33' E$) lies about 5 km E of Uotsurijima. It is 0.3 km^2 and 124.5 m maximum elevation, and consists chiefly of a sandstone bed with an upheaved coral reef zone along the northern half of the coast (Takara 1962, Kizaki 1985). Minami-kojima ($25^{\circ} 42' N$, $123^{\circ} 34' E$) is about 200 m SE of Kita-kojima. It is 0.5 km^2 and 146.9 m maximum elevation, and consists of two areas of sandstone beds and a mass of upheaved coral reef joining them (Takara 1962, Kizaki 1985). Kobisho ($25^{\circ} 56' N$, $123^{\circ} 41' E$) is about 27 km NE of Uotsurijima and is 1.1 km^2 and 118 m maximum elevation. Kobisho is com-

posed of igneous rocks obviously from a lava flow (Takara 1962, Kizaki 1985). The bare rock and a few crater remnants led Kizaki (1985) to suggest that this island first emerged as a volcano during the Pleistocene. There are no permanent springs or streams on these latter three islands. They also lack large woody plant species (Masaki 1941, Niiro 1964, Kizaki 1985).

METHODS

The itinerary of N.S. and S.I. was as follows: Kita-kojima, daytime of 24 May; Minami-kojima, evening of 24 May to noon of 25 May; Kobisho, evening of 25 May to morning

of 27 May; and Uotsurijima, noon of 27 May to morning of 29 May. Each island was surveyed in as many environments as possible, from the bare rocky zone near the coast inland to grassland and the forest (except for Kita-kojima, which has no forest at all). The survey took place during both day and night, except on Kita-kojima.

Morphological features of the specimens were examined after preservation. In the following section, zoological collections of Kyoto University (Department of Zoology), University of the Ryukyus (Department of Biology), and Okinawa Prefectural Museum are referred as KUZ, URB, and OPM, respectively.

SPECIES ACCOUNTS

Gekko hokouensis Pope

Fourteen specimens (Uotsurijima: 7, KUZ 21161 and six uncatalogued specimens; Minami-kojima: 2, KUZ 21162 and one uncatalogued specimen; Kobisho: 5, KUZ 21164 and four uncatalogued specimens) were found mainly in crevices of rocks near the coast during the day. On Uotsurijima, several individuals occurred beneath the bark of dead trees. This gecko was active on rock surfaces and tree trunks at night. On Minami-kojima, it was found on drifts of trees near the coast. Four additional specimens from Uotsurijima (from surveys in 1971 and 1979) are in URB (REP124–127). Two of these specimens were referred to *Gekko japonicus* (Duméril & Bibron) by Ikehara and Shimojana (1971).

All specimens ($n = 18$) have the usual characteristics of *G. hokouensis* (e.g., snout-vent length [SVL] 44.9–58.8 mm ($\bar{x} = 54.8$), entire subdigital scansors, single cloacal spur, dorsal tubercles, and absence of tubercles on limbs [Ota 1989]). This species occurs throughout the Ryukyu Archipelago, Taiwan, and eastern continental China (Ota 1991). Preliminary comparisons showed no recognizable differences in external characters between the present specimens and those from other Ryukyu Islands ($n = 101$) and Taiwan ($n = 73$; see Kohno and Ota (1991) for localities).

Eumeces elegans Boulenger

Four specimens (Minami-kojima: 1, KUZ 18077; Kobisho: 3, KUZ 21165–21167) were collected. On Minami-kojima, this skink lived around rocks and forests near the coast, whereas on Kobisho it was found around the border between the inland bare rocks and shrubs near the coast. Several individuals were also observed near the coast, but not in the forest, on Uotsurijima. Five specimens from Uotsurijima and five from Minami-kojima (from surveys in 1971 and 1979) are in URB (uncatalogued), OPM (UC1-4), and KUZ (18921–18924).

All specimens are characteristic of *E. elegans*: SVL of adults ($n = 7$) 67.0–75.2 mm ($\bar{x} = 71.0$), enlarged and irregularly arranged postfemoral scales and a pair of keeled postnasal scales (Hikida 1989) present, and no postnasals. Six specimens have a juvenile color pattern of five light lines against the dark ground color; the dorsolateral line wholly enters the ear opening. The others exhibit adult coloration and lack such lines.

Eumeces elegans occurs widely in Taiwan and southeastern continental China (Ota 1991) but not elsewhere in the Ryukyu Archipelago (Toyama 1989). No variation exists between Taiwanese and continental populations or among continental populations (Taylor 1935, Hikida 1986). There is, however, a slight difference in the number of scale rows at midbody between the Senkaku sample and samples from Taiwan and the continent; most (nine) of the former have 28 rows ($\bar{x} = 27.7$, 26–29, $n = 13$), whereas most from Taiwan (106/150) and the continent (45/61) possess 26 rows.

Scincella sp.

This small, diurnal brown skink lives on the forest floor on Uotsurijima; however, none was captured. The lizard was not seen on the other islands visited and no specimens now occur in museum collections. Although we were unable to examine a specimen of *Scincella* sp. from the Senkaku Group, Toyama (personal communication) once examined two specimens from Uotsurijima in 1971 and confirmed the identity of this population.

Takara (1954) first reported *Leiolopisma laterale* (Say) (i.e., *Scincella* sp. sensu Mittleman [1950, 1952]) from the forest of Uotsurijima. While allocating *Leiolopisma* to subgeneric status of the widely distributed genus *Lygosoma*, Nakamura and Uéno (1963) combined the population of Uotsurijima with those of the Yaeyama and the Miyako groups into a single subspecies, *Lygosoma (Leiolopisma) reevesii boettgeri* (Van Denburgh). Ikehara and Shimojana (1971) reported that this skink also occurs on Kobisho. None of those authors, however, described the morphology of Senkaku specimens or compared them with individuals from neighboring localities, such as the Yaeyama Group, Taiwan, and eastern continental China.

Ramphotyphlops braminus (Daudin)

This tiny, secretive snake was not found during the survey reported here. As has been reported already, one specimen (OPM H0546: SVL = 91.6 mm), collected from Uotsurijima during the 1979 survey, showed no differences from specimens from Taiwan or other Ryukyu Islands (Ota et al. 1991).

Elaphe carinata carinata (Günther)

Two individuals were observed at the border between the forest and grassland during the day on Uotsurijima. One, an adult male (KUZ 18076), was captured. None was observed on the other islands. Two specimens (URB, uncatalogued) were collected in 1979.

Takara (1954) and Ikehara and Shimojana (1971) reported this snake from Minami-kojima and Kita-kojima. Moreover, Takara (1962) stated that *E. c. carinata* also occurs on Kobisho; however, he provided no evidence of specimens to substantiate the record. Thus, verification is needed for Kobisho.

Elaphe carinata occurs widely in eastern and southeastern China, including Taiwan and northern Indochina (Ota 1991). Within the Ryukyus, it is confined to Yonagunijima of the Yaeyama Group and the Senkaku Group (Takara 1962). Meristic characters of three Senkaku specimens (SVL: 1250–1421 mm, \bar{x} = 1363) and those described by Takara

(1962) are similar to those of Taiwanese and continental samples described by Maki (1931) and Pope (1935), respectively. They are, however, distinct from the Yonagunijima population in having 23 midbody scale rows; the latter population, usually regarded as an endemic subspecies, *E. c. yonaguniensis* Takara, possesses 25 midbody scale rows (Takara 1962, Nakamura and Uéno 1963).

Dinodon rufozonatus rufozonatus (Cantor)

An adult female (KUZ 18132: SVL = 51.1 mm) was collected on the forest floor during the day on Uotsurijima. Another adult female (URB REP128: SVL = 55.4 mm) was collected from this island during the 1979 survey.

Dinodon rufozonatus occurs widely in the eastern part of the continent, Taiwan, and the Miyako and Yaeyama groups of the southern Ryukyus (Takara 1962, Ota 1991). Based on lower counts of ventrals and transverse dark-light body bands and absence of reddish coloration in light bands, populations of the Yaeyama and the Miyako groups are regarded as a distinct subspecies, *D. r. walli* Stejneger, rather than the nominotypical one from Taiwan and the continent (Stejneger 1907, Maki 1931, Nakamura and Uéno 1963). Both of the specimens from Uotsurijima showed slight but distinct reddish coloration in the light bands on body and tail. This coloration and the relative similarities of meristic characters (Table I) suggest that the Uotsurijima population is more closely related to the Taiwanese and continental populations than to those of other parts of the southern Ryukyus.

DISCUSSION

Unconfirmed Records

Takara (1954) reported *Hemidactylus frenatus* Duméril & Bibron from the forest on Uotsurijima. No individuals were observed and no vocalizations were heard there during recent fieldwork (i.e., 1971 and 1979 surveys [Ikehara, unpublished data], and the survey reported here). No specimens of this gecko

TABLE 1
MERISTIC CHARACTERS OF *Dinodon rufozonatus* FROM SEVERAL LOCALITIES

SUBSPECIES	LOCALITY	<i>n</i>	VT	SC	BB	TB
<i>rufozonatus</i>	Uotsurijima	2	193.5 (192–197)	79.0* (79)	55.0 (51–59)	22.0* (22)
	Taiwan	14	196.2 (182–204)	84.3 (79–89)	54.1 (50–60)	22.8 (16–29)
	Continent	17	201.0 (185–213)	72.9 (64–88)	59.5 (54–67)	18.1 (15–21)
<i>walli</i>	Yaeyama Group	89	188.8 (176–202)	81.2 (68–89)	30.0 (21–47)	16.4 (6–26)
	Miyako Group	8	182.9 (180–190)	82.8 (78–86)	25.1 (20–30)	16.3 (14–18)

NOTE: Data presented as means, followed by ranges in parentheses. Data for the continental sample are those provided by Pope (1935). Other data are from the study reported here. VT, ventrals; SC, subcaudals; BB, body bands; TB, tail bands.

* Examined for only one individual having an undamaged tail tip.

were found among previous collections either. Thus, we suspect that Takara's (1954) record was either a misidentification of specimens or specimens with wrong locality records and that *H. frenatus* does not actually occur in the Senkaku Group.

Populations of *Gekko* in the Ryukyus, Taiwan, and eastern continental China were long considered a single species, *G. japonicus*. Recently, it was discovered that there are actually two species, *G. japonicus* and *G. hokouensis*, and that most, if not all, populations in the Ryukyus and Taiwan and part of those in continental China belong to the latter species (Zhou et al. 1982, Ota 1986, 1989, 1991, Ota et al. 1989). This conclusion requires reexamination of all other East Asian populations referred to *G. japonicus* (sensu lato: e.g., Shibata 1989, Hikida et al. 1992). Ikehara and Shimojana (1971) reported *G. japonicus* from Uotsurijima, Minami-kojima, and Kobisho, but our results and the above-mentioned changes suggest that the occurrence of *G. japonicus* (sensu stricto) in the Senkaku Group is unlikely.

Several previous authors have stated that *Eumeces marginatus* (Hallowell), a skink known from the central Ryukyus, also occurs in the Senkaku Group (Miyajima 1901, Takara 1954, Ikehara and Shimojana 1971). None of those authors, however, provided adequate data to confirm the identity of skinks observed and/or collected. We found

no *E. marginatus* among the Senkaku *Eumeces*; all were *E. elegans*. The two species are very similar, and their distributions in the Ryukyus and Taiwan have often been wrongly documented as a result of misidentifications (see Hikida [1989] for review). Thus, we suspect that records of *E. marginatus* from the Senkaku Group are also incorrect.

Herpetofaunal Characteristics of the Senkaku Group and Their Historical Significances

Six species and subspecies of reptiles occur in the Senkaku Group, but no amphibians. Of the six reptiles, *G. hokouensis* and *R. braminus* occur throughout most of subtropical East Asia, including the other island groups of the Ryukyu Archipelago, Taiwan, and the continent, and thus offer no data on the affinities of the Senkaku herpetofauna. Without a specific identification, the Senkaku *Scincella* is similarly noninformative. The remaining three taxa, *E. elegans*, *E. c. carinata*, and *D. r. rufozonatus*, do not occur in the rest of the Ryukyu Archipelago and are shared exclusively with Taiwan and the continent, demonstrating a faunal affinity of the Senkaku Group with eastern China.

Recent geohistorical studies reveal that land area was larger globally during the late Pleistocene (15,000 to 18,000 yr ago) than now because of lower sea level during continental glaciation. Estimates of the sea level drop vary

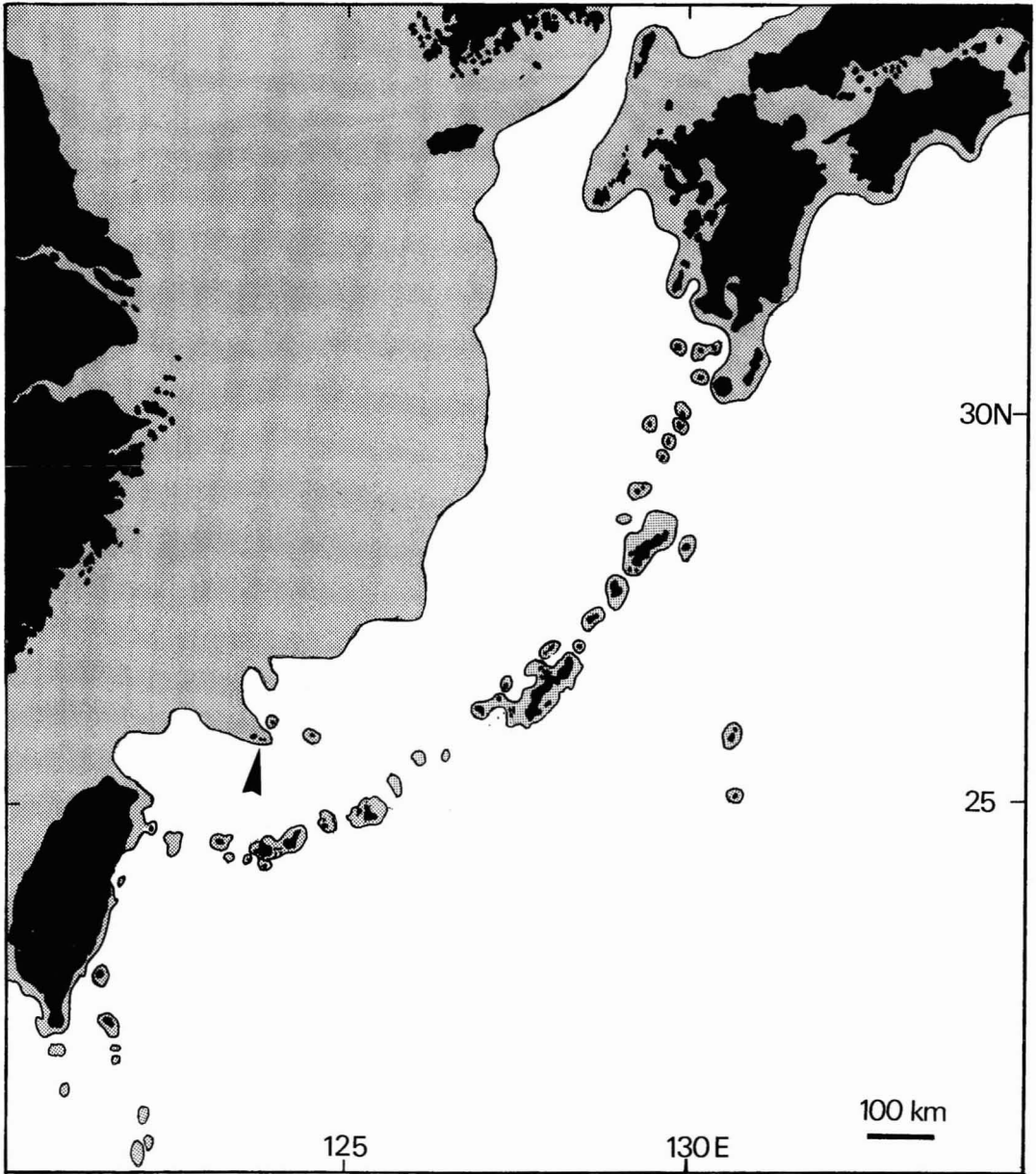


FIGURE 2. Map of East Asia, showing the current land areas (darkened portions) and minimally estimated additional land areas exposed above sea level during the late Pleistocene (currently submerged by the sea but as deep as, or shallower than, 120 m: stippled portions). Note that islands of the Senkaku Group (indicated with an arrow) were attached, or adjacent, to the continent during the late Pleistocene.

from 120 to 140 m (Donn et al. 1962, Kizaki and Oshiro 1980, Hopkins 1982). On the other hand, geomorphological changes such as uplifting or subsidence by tectonic movement

within the last 20,000 yr are supposed to be negligibly small in East Asia (Kizaki and Oshiro 1980, Ujiie 1991). Therefore, the configuration of land areas during the late Pleis-

tocene can largely be reconstructed simply by drawing lines around areas above 120 or 140 m below the current sea level.

The minimum estimate of land areas during the late Pleistocene are depicted in Figure 2, drawn on the basis of depth charts of related regions by the Maritime Safety Agency (1978). This map shows that Uotsurijima, Kita-kojima, Minami-kojima, and Taiwan were fused as an eastward extension of the continent during the last glacial period. Kobisho may have been separated from the continent by a narrow strait, because current depths are as deep as or deeper than 140 m. Even so, it was much closer to the continent than to other parts of the Ryukyus, which would have been not much different from current configurations (Figure 2). The Senkaku Group seems to have been isolated from the continent and Taiwan only recently (i.e., less than 15,000 yr ago) with rising sea level.

The herpetofauna of the Senkaku Group, with its similarity to that of Taiwan and the continent, can be explained by the above-mentioned paleogeographical scenario. Obviously, those species exclusively shared with Taiwan and the continent could have migrated to Uotsurijima, Minami-kojima, and Kita-kojima through the area exposed above the sea during the late Pleistocene. Those on Kobisho might have had to cross a narrow strait by rafting, but the herpetofaunas of other parts of the Ryukyus are also considered as having partially dispersed by rafting (e.g., Kohno and Ota 1991, Hikida et al. 1992). The significance of the apparent differentiation of *E. elegans* and the taxonomic status of *Scincella* sp. in the Senkaku Group require future studies.

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