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Reconsideration of the actual type locality of the lesser Japanese shrew-mole, *Dymecodon pilirostris*

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Abstract: In the original description of the lesser Japanese shrew-mole, *Dymecodon pilirostris*, by True (1886), its type locality is described as "Yenosima, at the mouth of the Bay of Yeddo, Japan." Yenoshima is the current Enoshima, a small island located not in Tokyo Bay (the Bay of Yeddo) but in the mouth of Sagami Bay facing the Pacific Ocean, Kanagawa Prefecture, in eastern Honshu, Japan. The type locality has been considered to be doubtful because Enoshima is not included in *D. pilirostris'* distribution, which mainly consists of rocky terrain in mountainous areas. In this paper, we tried to elucidate the cause of the error of the type locality and the actual type locality based on travels of Edward S. Morse who brought the type specimen to the United States. On the basis of his activities during his first stay in Japan before the relegation of the specimen from the Boston Museum of Natural History to the National Museum of Natural History in 1878, we can see that, on most days, he stayed in Tokyo and its neighboring areas, which lay outside the distribution of *D. pilirostris*. On the other hand, he once went to collect invertebrates in a location that is included in mountainous area – Nikko, Tochigi Prefecture, eastern Honshu. If he obtained the shrew-mole himself, the type locality is likely not Enoshima but Nikko. Here, we suggest that the type locality of *D. pilirostris* should be corrected from "Enoshima" to "Nikko", according to the recommendation 76A.2 in the article 76 of ICZN.

Keywords: *Dymecodon pilirostris* - type locality - Edward S. Morse - Enoshima - Nikko.

INTRODUCTION

Enoshima, a small island (35˚17'N, 139˚28'E; circumference: 4 km, maximum height: 60 m; Fig. 1), is located near a sandy beach facing Sagami Bay, Fujisawa, Kanagawa Prefecture of central Honshu, Japan (Figs 1 and 2) that is now connected by a concrete bridge (approximately 400 m length) across a narrow shallow (Fig. 1). Geohistorically, Enoshima had been isolated since the last glaciation due to the retreating sea level, particularly during the Jomon transgression (Fujisawa Board of Education, 1995). In addition, stone tools from the Jomon period were discovered (Tamagawa Institute of Cultural Resources, 2019) on this island, which has been considered a holy place due to the Enoshima Shinto Shrine, a typical historical landmark present since the dawn of history (Hattori, 1979). Since the Edo period, Enoshima has been a famous sightseeing point near the Tokyo Metropolis, and after World War II, many amusement facilities, such as fishing areas, a yacht marina, restaurants, and souvenir shops, have been built. Enoshima was completely connected with the opposite sandy beach in 1897 by a coarse wooden bridge (Tamamuro, 1991; Fujisawa Board of Education, 1995); subsequently, many people have been able to visit there easily. Since the completion of the concrete bridge, recently, over 10 million people visited the island annually (Fujisawa City Tourist Association, 2022). Therefore, it is possible that some organisms have been introduced artificially and accidentally, particularly plants. The current climate of Enoshima is mild and relatively warm, and this island has various types of vegetation. Ever-green plants observed in warmer climate regions, such as marlberry (*Ardisia japonica*), chinkapin (*Castanopsis sieboldii*), Japanese tassel fern

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Fig. 1. (a) Map indicating localities related to the activities of E. S. Morse during his first stay in Japan in 1877. Shaded areas outlined by green dotted lines roughly indicate the current distributions of *Dymecodon pilirostris* (Kobayashi & Kitahara, 1968; Ohdachi *et al*., 2015). Kanagawa Prefecture and Tochigi Prefecture are indicated by white dotted lines. (b) Area magnified in Fig. 2, corresponding to an illustration map drawn by Morse (1917a) himself.

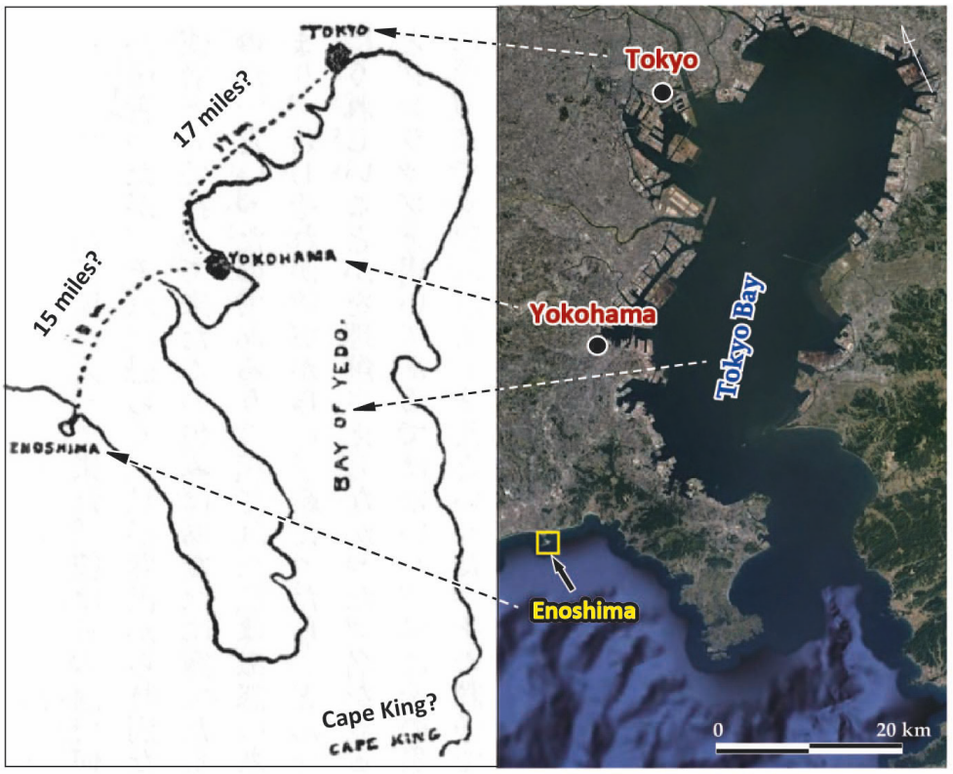

Fig. 2. (left) Illustration map drawn by Morse (1917a) himself according to "Japan, Day By Day" vol. I (p. 163, fig. 137) and (right) its corresponding area (b in Fig. 1), indicating the geographical settings of Tokyo, Yokohama, and Enoshima. Notes as "17 m" from Tokyo to Yokohama and "15 m" from Yokohama to Enoshima probably mean 17 miles and 15 miles, respectively. "Cape King" corresponds to Susaki (current Cape Sunosaki) of the Boso Peninsula according to Rittau (1880) and Akioka (1930).

(*Polystichum polyblepharum*), red machilus (*Machilus thunbergii*), Japanese spindle (*Euonymus japonicus*), and cheesewood (*Pittosporum tobira*), are mainly present in the island's interior, including introduced species (Fujisawa City, 2003; Ministry of the Environment, Japan: http://www.vegetation.jp/).

The lesser Japanese shrew-mole, *Dymecodon pilirostris* (Soricomorpha, Talpidae, Scalopinae), was first described by Frederick W. True in 1886 as a new genus and a new species (True, 1886; Ohdachi *et al*., 2015) that differed from the greater Japanese shrew-mole, *Urotrichus talpoides*, in dentition and external morphology. According to the description, the collector was Edward S. Morse, and the type locality was recorded as "Yenosima, at the mouth of the Bay of Yeddo, Japan" (True, 1886). This type locality is thought to be the current Enoshima (Figs 1 and 2). In the Japanese Archipelago, *D. pilirostris* generally occurs in mountainous areas consisting of rocky terrains at relatively high altitudes; *U. talpoides* inhabits forests, bushes, and grasslands at lower to higher altitudes. Therefore, Enoshima is currently not included in the potential distribution of *D. pilirostris*, nor probably *U. talpoides* (Ohdachi *et al*., 2015; Fig. 1).

In Kanagawa Prefecture, there are records of *D. pilirostris* at the higher altitudes (> 900 m) of the Tanzawa Mountains, far from Enoshima (> 20 km) (Kobayashi & Kitahara, 1968; Kobayashi & Yamaguchi, 1971; Imaizumi *et al*., 1980; Hirotani, 2003; Yamaguchi, 2003; Fig. 1). Enoshima is separated from the Tanzawa Mountains by an alluvial plain, the Sagami Plain, which contains alluvial sediment mainly from the Sagami River. It is estimated that Enoshima and the Tanzawa Mountains are not related biogeographically (Kaizuka & Moriyama, 1969; Fig. 1). On the other hand, introduced mammals, such as feral cats (*Felis catus*) and squirrels (*Callosciurus erythraeus*), are found everywhere in Enoshima (Fujisawa City, 2003). The fauna and flora have been disturbed by introduced organisms and it is thought that the original environment of Enoshima is already lost, unfortunately. It has been considered that the vegetation and environment of Enoshima are not biogeographically and ecologically suitable for *D. pilirostris*. Therefore, it is difficult to establish whether *D. pilirostris* currently occurs in Enoshima. Hence, considering the overall distribution of *D. pilirostris* and the current local environment, geological context, geographic settings, and human history of Enoshima, the type locality – present-day Enoshima – appears doubtful, as suggested, for example by Imaizumi (1960).

If the type locality of *D. pilirostris* is wrong, why did

such an error occur? Where is the actual type locality? In this paper, we try to elucidate the cause of the error about the type locality and estimate the more likely type locality based on the literature, especially related to Morse's activities during his stay in Japan.

RESEARCH METHODS

Morse traveled to several places – Hokkaido, northeastern Honshu, western Honshu, and Kyushu – during his several stays in Japan starting in 1877. However, according to Poole & Schantz (1942), the specimen of *D. pilirostris* collected by Morse was moved from the Boston Society of Natural History to the National Museum of Natural History on February 19, 1878. Morse therefore had only visited Japan once before this transfer. Because of these date constraints, we investigated his activities during his first stay in Japan, from June to November 1877 (Morse, 1917a, b, 1970a, 1983; Howard, 1935; Hattori, 1979; Yoshikawa, 1985; Isono, 1987; Moriya, 1988; Nakanishi, 2002; Konishi & Oka, 2005; Makino, 2009). In addition, we checked the storage condition of the type specimen of *D. pilirostris* deposited at the National Museum of Natural History, Washington DC, USA in order to estimate its state at the time when Morse obtained it.

RESULTS AND DISCUSSION

At the beginning of the description by True (1886), there is an important section: "Seven years ago, at the request of Prof. E. S. Morse, the authorities of the Boston Society of Natural History sent to the National Museum two specimens of mammals in alcohol, from Yenosima, at the mouth of the Bay of Yeddo, Japan. The bottle in which they were contained having been misplaced, they have remained unidentified until the present time. One of the specimens is a common house-rat, *Mus decumanus*; the other is an insectivore belonging to a genus hitherto undescribed. The latter specimen closely resembles *Urotrichus talpoides* in general appearance but differs in dentition as well as in proportions" (*M. decumanus* is currently synonymized with *Rattus norvegicus* according to Wilson & Reeder, 2005). This paragraph implies that these specimens had not been stored in the correct place for mammals at the National Museum of Natural History and had been deposited for seven years along with aquatic organisms that were collected by Morse mainly from Enoshima.

Morse, who brought these specimens into the United States, studied aquatic invertebrates and discovered the Shell Mounds of Omori in the Tokyo Metropolis in Japan (e.g., Morse, 1983; Table 1). During his first stay in Japan, he became a part-time professor at the University of Tokyo and introduced the evolutionary theory of Darwin in his lectures. In addition, he also collected aquatic organisms from rivers, lakes, and seas. Moreover, he politely recorded Japanese culture, traditions, and lifestyles in his diaries with clear illustrations; today, his publications are important and useful ethnologically (e.g., Morse, 1979). His diaries and writings suggest how he was punctilious and had tidy personality.

His main interest was studying lingulids (brachiopods), and he set up a marine laboratory station in Enoshima in 1877 (Morse, 1917a; Table 1). Thus, Morse collected many samples of aquatic organisms and brought them to the United States with the two mammalian specimens. Considering these evidences, True (1886) possibly erred in designing the type locality of *D. pilirostris* as Enoshima, where Morse collected his aquatic organisms.

Table 1. Main activities of E. S. Morse during the period of his first stay (1877) in Japan.

Date		Activity
Jun.	17	Arrived at Yokohama Bay after a 17-day journey from the United States (Fig. 1). Stayed in the Yokohama Grand Hotel until June 28.
	19	Discovered the Shell Mounds of Omori from inside a train on the way from Yokohama to Shimbashi, Tokyo, to meet Dr David Murray, the Superintendent of Education (Fig. 1).
	20	Attended a reception on the US battleship *Tennessee*. Went to Tokyo and stayed at Dr Murray's house.
	21	Visited the Faculties of Law, Science and Literature at the University of Tokyo. Returned to Yokohama.
	24	Went to Tokyo and visited the Educational Museum of the Ministry of Education.
	26	Lectured about general natural history at the University of Tokyo.
	29	Left Tokyo with Dr. Murray at 4:00 a.m. and traveled 3 miles (≈ 4.8 km) to a stagecoach terminal by rickshaw. Furthermore, traveled 66 miles (≈ 106 km) to Utsunomiya by stagecoach (Fig. 1).
	30	Traveled 26 miles (≈ 41 km) to Hashiishi (current Hachiishi, alt. 2,000 foot ≈ 600 m), Nikko, by rickshaw (Fig. 1).
Jul.	2	Traveled 8 miles (≈ 12 km) to Chuzenji (alt. 4,000 feet ≈ 1,200 m) by palanquin (Fig. 1).

	3*	Climbed Mount Nantai-san (alt. 8,175 feet ≈ 2,500 m). After the climb, traveled to a Japanese-style inn at Chuzenji (Fig. 1).
	4*	Collected freshwater shells from a small ship at Lake Chuzenji-ko with a party member (Fig. 1). After the collection, traveled to Hashiishi (now Hachiishi) alone and captured insects, mainly butterflies and beetles.
	5–6*	Stayed for two days at an inn near Lake Chuzenji-ko because of rainy weather. Wrote letters and diaries.
	7	Left for Tokyo at 5:00 a.m. by rickshaw. Arrived at Nowata and transferred to a river ship. Went down the Tonegawa River. Stayed in the ship one night (Fig. 1).
	8	Got off the ship at a site 10 miles (≈ 16 km) from Tokyo. Traveled to Tokyo by rickshaw.
	12	Formally took office as a professor of the Zoological Institute, Department of Biology, Faculty of Science, at the University of Tokyo.
	17	Visited Enoshima for the first time to arrange the construction of a marine laboratory (Fig. 1).
	18	Returned to Yokohama.
	21	Traveled to Enoshima from the Yokohama Grand Hotel by rickshaw. Researched aquatic organisms at the marine station laboratory through August 29. Collected many samples of aquatic animals.
	24	Researched a cave in Enoshima and collected insects and other organisms. Traveled to Yokohama in the afternoon.
	25	Returned to Enoshima from Yokohama in the early evening.
	28	Traveled to Yokohama and returned to Enoshima.
Aug.	3	Traveled to Tokyo.
	4	Returned to Enoshima at night.
	11	Enjoyed swimming with Professor Toyama and Assistant Professor Matsumura at an Enoshima beach.
	18	The opening ceremony of Educational Museum was held. Morse's attendance is unclear.
	21	Attended the opening ceremony of the first National Industrial Exhibition at Ueno, Tokyo. Returned to Enoshima.
	27	Attended a meeting at the University of Tokyo. That afternoon, he returned to Enoshima.
	28	Packed up many items and closed the marine station laboratory.
	29	Left Enoshima and traveled to Tokyo by rickshaw. Stayed in Yokohama one night.
	30	Arrived in Tokyo. All of his collected samples were brought by ship from Enoshima and transported to Tokyo.
Sep.	12	Lectured for the first time to students at the University of Tokyo.
	16	Performed the first research of an excavation at the Shell Mounds of Omori.
	18	Performed the second research of an excavation at the Shell Mounds of Omori.
Oct.	3	Attended a meeting of the Asiatic Society of Japan at Yokohama Grand Hotel at night. Introduced the results of excavation research at the Shell Mounds of Omori.
	6	Lectured about general natural history at the University of Tokyo.
	9	Performed the third research of an excavation at the Shell Mounds of Omori.
	15	Introduced "a palaeontological discovery at Bushu Ohmori" at the University of Tokyo.
	20	Lectured on "the origin of human in the evolution" at the University of Tokyo.
Nov.	2	Left Tokyo and traveled to Yokohama.
	5	Left Yokohama to temporarily return to his country.

*Activities during which *D. pilirostris* could have been obtained within its current distribution area, as inferred by current research.

True's type locality of *D. pilirostris* was, however, problematic in several ways. Morse's illustration (Morse, 1917a, 1970a; Fig. 2) shows that the present Tokyo Bay was described as the "Bay of Yedo," and "Enoshima" was located on the shore of present Sagami Bay on the west side of the Miura Peninsula (Figs 1 and 2). Morse already knew the difference between the current Tokyo Bay and Sagami Bay at the time, as seen in Fig. 2. Therefore, at least, True's "mouth of the Bay of Yeddo" is apparently mistaken and is far from Enoshima. In addition, although Morse used "Enoshima" and "Yedo" in his spellings, True used instead "Yenosima" and "Yeddo" suggesting that he did not follow Morse's original descriptions and added confusion with actual localities.

If Enoshima is not the type locality of *D. pilirostris*, where could it be located? We estimated that Morse obtained the *D. pilirostris* specimen himself at another locality, possibly in a mountainous area, considering the current distribution pattern of *D. pilirostris* and the geographic features of Enoshima (Ohdachi *et al*., 2015; Fig. 1). We reveal his activities at the time of his first stay in Japan based on his diaries, related publications, and biography in Table 1 (Morse, 1917a, b, 1970a, b, 1971; Isono, 1987). During his first stay in Japan, his only travel was a visit to Nikko, a mountainous area of Tochigi Prefecture in eastern Honshu, which is included in the current distribution of *D. pilirostris* (Morse, 1917a, b, 1970a, b, 1971; Fig. 1). Except for this journey to Nikko, he spent the rest of his time around Tokyo, including Yokohama and Enoshima, which lay outside the distribution of *D. pilirostris* (Fig. 1). Therefore, he likely did not obtain the *D. pilirostris* specimen around Tokyo. In addition, if a person brought it to Morse, he would have noted the name of the collector, considering his fastidious personality, which is evident from his diaries. As there is no notice or description about the collector of the specimen, and it seems improbable to have been collected by someone else. The type specimen of the shrew-mole was most likely obtained by Morse himself, from a locality included in the distribution of *D. pilirostris*.

Although Lyon & Osgood (1909) and Poole & Schantz (1942) mentioned that the body of the type specimen of *D. pilirostris* was in rather bad condition, the type has been stored in relatively good condition based on our examination (Fig. 3). The skull and mandible are slightly broken (No. 22139), and the body (No. 15291) is preserved in ethanol. The belly fur is partially lost, but elsewhere it remained almost entirely (Fig. 3). On the basis of such good storage conditions, the specimen was probably obtained in a relatively fresh condition – at least without putrescence. In addition, considering the way of life in the late 1800s, including the absence of cooling systems such as refrigerators or ice makers and quick transportation methods, it would be impossible for a person to bring a shrew-mole in a fresh condition back to Tokyo from its neighboring areas from a mountainous area. Moreover, on the basis of Morse's activities, most

Fig. 3. The type specimen of *Dymecodon pilirostris* stored at the Smithsonian Museum of Natural History. (a) bones (No. 22139). (b and c) Labels. (d) Body in alcohol with labels (No. 15291).

of his travel from Tokyo to Nikko and its neighboring areas was by rickshaw or stagecoach. Only on July 3-4, he climbed Mount Nantai-san on foot and collected animals (insects and aquatic invertebrates) around Lake Chuzenji-ko. On July 5-6, he stayed in a house near the lake because of rainy weather (Table 1). Accordingly, he likely obtained the shrew-mole from there and quickly put it in a certain fixative. We therefore conclude that the type specimen must have been obtained in early July 1877 at or near Lake Chuzenji-ko in Nikko (Morse, 1917a, b, 1970a, b; Table 1).

As mentioned above, the type specimen of *D. pilirostris* is preserved in relatively good condition. There are five labels attached to the specimen, and, based on their handwriting patterns, those were written by four people (Fig. 3). Three of them (Fig. 3b-iii, c, d) seem to be relatively newer, and these descriptions are in accordance with those of True (1886); two (Fig. 3b-iii, d) seemed to be written by the same person. The other two labels (Fig. 3b-i, -ii) seem to have been written by different people. In one of them (Fig. 3b-ii), "United States" and "National Museum" were printed. The final label (Fig. 3b-i) also indicated the specimen Nos. "152910" and "22139" as the series of the National Museum of Natural History. Therefore, at least according to these five labels (Fig. 3b-i, -ii, -iii, c, d), the description seemed to be added after transportation from the Boston Museum of Natural History to the National Museum of Natural History. In addition, the expressions used in the specimen notebook (Fig. 4) are the same as those of True (1886). Thus, all of the descriptions in the type specimen labels and notes corresponds to those of True (1886), and there are no hints about the actual type locality of *D. pilirostris* in these descriptions.

Considering Morse's fastidious personality, it is expected that he must have noted or labeled the collecting locality

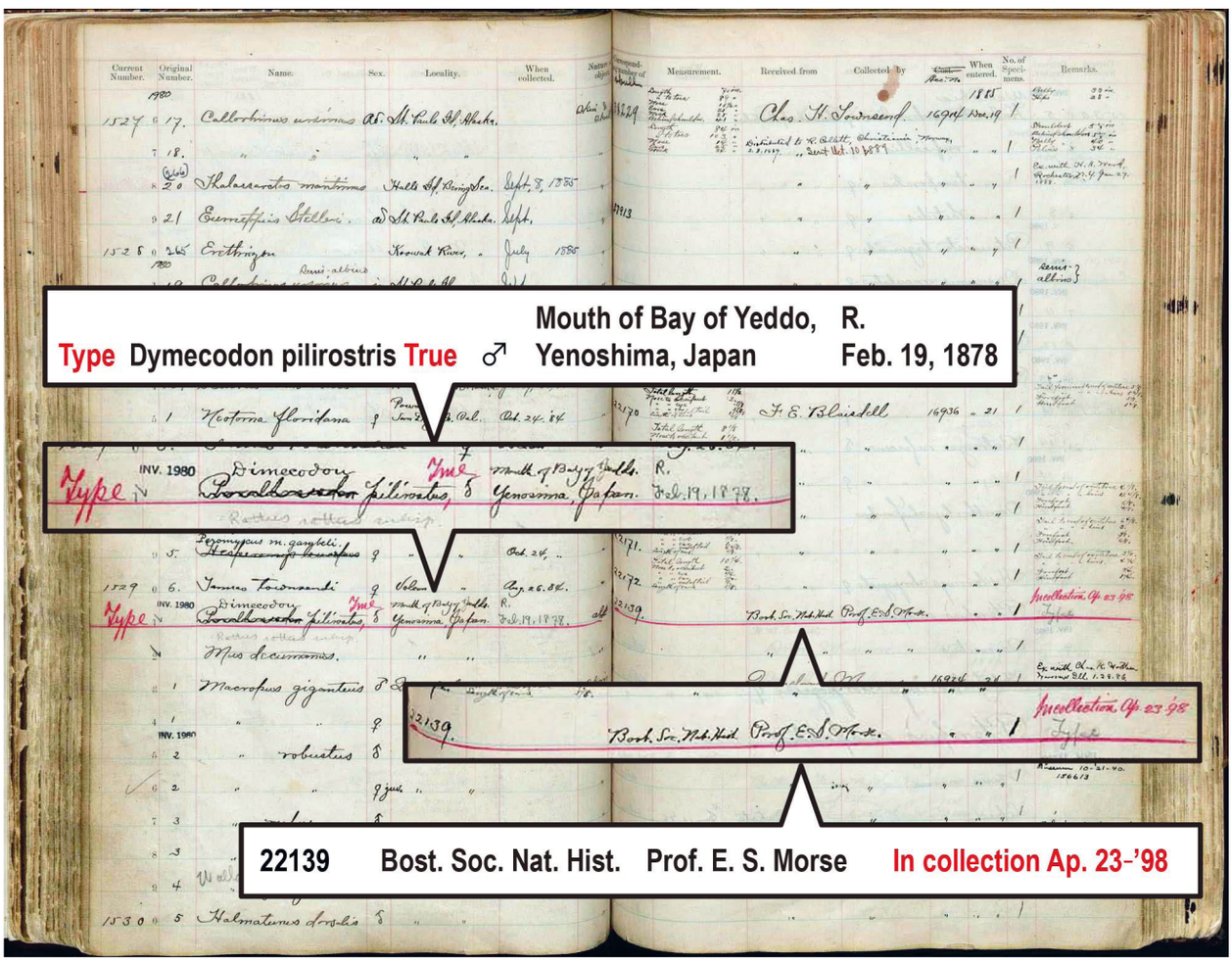

Fig. 4. The scanned record of the type specimen of *Dymecodon pilirostris* (No. 15291, indicated by a red-colored underline) in the specimen notebook, referred from the Mammal Collections, National Museum of Natural History (http://n2t.net/ark:/65665/3eb485d00-46c2-494b-80ea-69f775cb7591), with magnifications and translations by the authors. This record is fundamentally the same as the description of True (1886). In column of "When collected." at line No. 15921, the date given is "R. Feb. 19, 1878"; this was not the date of collection but the date that the type specimen of *D. pilirostris* was transferred from the Boston Society of Natural History to the National Museum.

for the *D. pilirostris* specimen at that time. However, unfortunately, his notice might have been lost during its transportation from Japan to the United States, or from the Boston Museum of Natural History to the National Museum of Natural History. In addition, around 1886 when *D. pilirostris* was described, True had worked as a curator of mammals in the United States National Museum from 1883 to 1909 (https://sova.si.edu//record/SIA.FARU7181, accessed 2022-9-17). On the other hand, Morse revisited Japan in 1882 to 1883 to collect clay and ceramics with a devotion to Japanese culture history, and he became the president of the American Association for the Advancement of Science in 1886 (Dall, 1926). On the basis of the situation during this era, their scientific connections were likely poor, which may have misled True about the real origin of the specimen.

Based on Morse's activities at the time of his first stay in Japan, we therefore suggest that the type locality of *D. pilirostris* should be corrected from "Enoshima (Yenoshima, at the mouth of the Bay of Yeddo, Japan)" to "Nikko (Nikko., Tochigi Pref., eastern Honshu, Japan)", according to the recommendation 76A.2 in the article 76 of the International Code of Zoological Nomenclature (ICZN, 1999). Unfortunately, all of the people related to the type specimen are deceased and we cannot obtain further important evidence about the actual type locality from them. Hopefully, DNA from the type specimen will be analyzed to evaluate local variations that would additionally support our current interpretation of the type locality of this taxon.

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