群馬県立自然史博物館研究報告(22)：1－21,2018
Bull.Gunma Mus.Natu.Hist. (22)：1－21,2018

Original Article

Birds around the Minatogawa Man: the Late Pleistocene avian fossil assemblage of the Minatogawa Fissure, southern part of Okinawa Island, Central Ryukyu Islands, Japan

MATSUOKA Hiroshige[1*] and HASEGAWA Yoshikazu[2]
[1]*Department of Geology and Mineralogy, Graduate School of Science, Kyoto University: Kyoto 606-8502, Japan.*
(*maca@kueps.kyoto-u.ac.jp*)
**Corresponding author*
[2]*Gunma Museum of Natural History: Gunma 370-2345, Japan.*
(*hasegawa@gmnh.pref.gunma.jp*)

Abstract: 17 avian species belonging to the 10 families of 8 orders were identified in the fossil assemblage of Minatogawa Fissure, the locality of the Late Pleistocene *Homo sapiens* "Minatogawa Man" fossils, Minatogawa, Yaese Town, the southern part of Okinawa Island, Ryukyu, Japan. They are: *Treron formosae* (Columbiformes: Columbidae), Columbidae gen. et sp. indet. (Columbiformes), *Phalacrocorax capillatus* (Suliformes: Phalacrocoracidae), *Nycticorax caledonicus* (Pelecaniformes: Ardeidae), Ardeidae gen. et sp. indet. (Pelecaniformes), *Gallirallus okinawae* (Gruiformes: Rallidae), *Porzana fusca* (Gruiformes: Rallidae), *Scolopax rusticola* (Charadriiformes: Scolopacidae), *Scolopax mira ohyamai* ssp. nov. (Charadriiformes: Scolopacidae), *Circus spilonotus* (Falconiformes: Accipitridae), *Buteo buteo* (Falconiformes: Accipitridae), *Otus lempiji* (Strigiformes: Strigidae), *Garrulus lidthi* (Passeriformes: Corvidae), *Corvus macrorhynchos connectens* (Passeriformes: Corvidae), *Hypsipetes amaurotis* (Passeriformes: Pycnonotidae), *Zoothera major* (Passeriformes: Muscicapidae), and *Turdus pallidus* (Passeriformes: Muscicapidae).

The avian fossil assemblage of Minatogawa is characterized by dominant forest-ground dwellers. Also the avian fossil assemblage of Minatogawa, that includes the fossils of *Gallirallus okinawae* (endemic to Yanbaru today), *Scolopax mira* (endemic to the Central Ryukyu Islands: breeds only in Amami Islands and migrates south in winter and appears on Yambaru of Okinawa Island and adjacent islands today), *Garrulus lidthi* (endemic to Amami-Oshima and neighboring Kakeroma and Uke islands today), and *Zoothera major* (endemic to Amami-Oshima and Kakeroma today) indicates a strong zoogeographical connection between the forest around Minatogawa and Yanbaru, the northern part of Okinawa, and Amami Islands across the straits to the north.

The fossils of *Scolopax mira* (Amami Woodcock) from Minatogawa are larger than the recent specimens. Especially the wings and head are developed than the recent population. We establish a new chronological subspecies, *S. mira ohyamai* ssp. nov., for the fossil form and distinguish it from the recent population, *S. mira mira*. Transition from *S. mira ohyamai* to *S. mira mira* was possibly rapid and occurred in very recent past. It is probable that the transformation from *S. mira ohyamai* to *S. mira mira* consequent on the reduction of the range after the Late Pleistocene. The relatively small wings in the recent *S. mira mira*, might be a result of adaptive selection for the reduced range.

Key Words: Late Pleistocene, Okinawa, Minatogawa, avifauna, endemic bird

INTRODUCTION

The Minatogawa Man, represented by at least four skeletons and some isolated bones, are a Pleistocene *Homo sapiens* population of Okinawa Island (Suzuki and Hanihara eds., 1982). Their skeletons are the most complete among the Pleistocene human remains in Japan and thus are central to the investigation on the earlier phase of peopling in East Asia (Suzuki and Hanihara, 1982; Baba and Narasaki, 1991; Kodera, 2006; Kaifu, 2007).

The locality of Minatogawa Man is the Minatogawa Fissure. It locates in Minatogawa, in the area of former Gushikami (Gushichan)-son Village, Yaese Town today, the southern part of Okinawa Island (Figure 1). The Minatogawa Fissure is a tectonic fissure splitting the last interglacial limestone, the Minatogawa Limestone (Tsuchi, 1982; Hasegawa et al, 2017). Though the neighboring geography had completely changed after the heavy mining of limestone and following residential development, until the 1970s, the fissure was observable on the terrace surface of about 20-40 meters above sea level, that is the depositional surface of the Minatogawa Limestone, as a shallow depression of some hundreds meters long with the strike of N60-70°W (Tsuchi, 1982). Radiocarbon of wood piece found nearby human remains dated at 18,250±650 and 16,600±300 BP (Suzuki and Tanabe, 1982), ca. 20,000-22,000 years ago, supporting the last glacial maximum stage for its depositional age.

Not only the Minatogawa Man remains but also numerous non-hominin vertebrate fossils were unearthed through the excavations of Minatogawa fissure-fill deposits. Coupled with the anthropological importance, as the fauna surrounded the Minatogawa Man, the outline and/or some significant species of the Minatogawa fossil assemblage have often been recorded (e.g., Takai and Hasegawa, 1971; Kowalski and Hasegawa, 1976; Hasegawa, 1980; Kawamura, 1989; Matsuoka, 2000; Hasegawa and Matsuoka, 2002; Okinawa Prefectural Museum & Art Museum, 2007; Yamasaki, 2016; Hasegawa et al., 2017). The Minatogawa fossil assemblage is, actually, one of the most important information source for the Late Pleistocene fossil vertebrates of the Ryukyu Archipelago.

Mr. Seiho Oyama (or, Ohyama, in a pronouncing spelling) and his family and colleagues, who carried out the great discovery of Minatogawa Man in 1968, recognized skeletal elements of birds as those of fowls and called them "Minatogawa Chicken" in the days of excavations. Now, as will be described later, "Minatogawa Chicken" showed its nature as the bones of the Okinawa Rail (*Gallirallus okinawae*) or Amami Woodcock (*Scolopax mira*). Regarding the Amami Woodcock fossils of Minatogawa, it was confirmed that the fossils represent a new subspecies in this study because of its much larger size than recent population. This paper then includes the description of a new chronological subspecies of Amami Woodcock. The resulting Minatogawa Paleoavifauna is highly suggestive for the original distribution of unique birds of the Central Ryukyu Islands. It consists mainly of forest dwellers and indicates the full-island distribution of forest environment in the past, which

Submitted：December 14, 2017; accepted：February 14, 2018

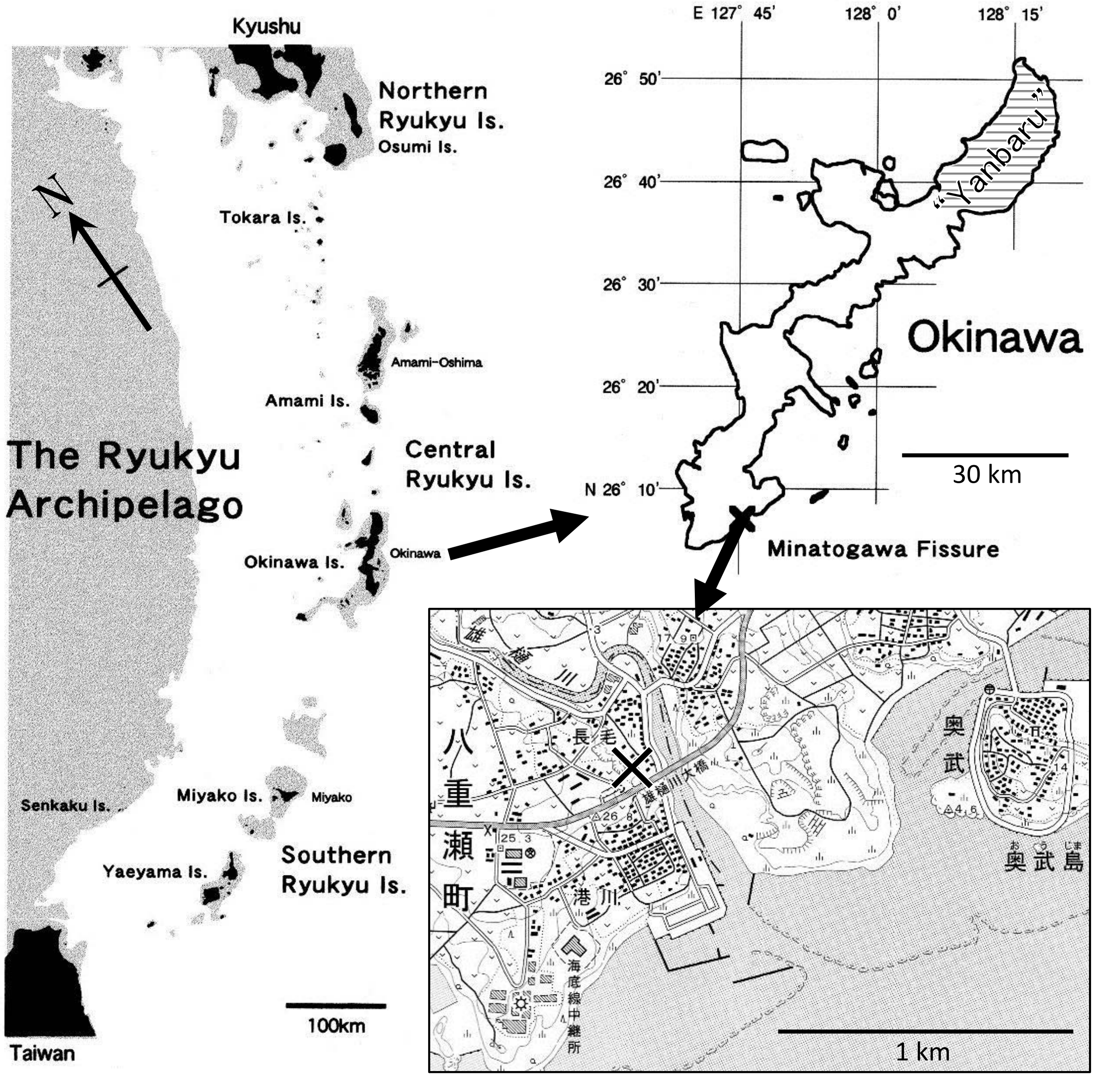


Figure 1. Locality map of the Minatogawa Fissure. The cross mark indicates the position of the Minatogawa Fissure. 1:25,000 scale topographic map "Chinen" by GSI is used.

is restricted today in the northern mountainous Yanbaru area of Okinawa Island.

MATERIAL and METHOD

See Tsuchi (1982) and Hasegawa et al. (2017) for the geological and paleontological background of the Minatogawa Fissure. More than 1,000 disarticulated bones of birds had been unearthed from the fissure-fill muddy deposits of Minatogawa Fissure during the late 1960'- early 70' excavations. About 1,000 of them are housed in the Okinawa Prefectural Museum & Art Museum (Mb series), and about 50 are in storage at Mr. Oyama's house (OMB series). After the unidentifiable elements, vertebrae and too-incomplete bones had been excluded from the investigation, totally 824 disarticulated bones of birds have been identified to genus - species level (Table 1).

For the identification, the osteological specimens of recent birds housed in the Department of Geology and Mineralogy, Faculty of Science, Kyoto University (KUGM), Okinawa Prefectural Museum (OPM), and Division of Birds, National Museum of Natural History, Smithsonian Institution (NMNH) were used for comparison.

The fossil assemblage of Minatogawa is strongly dominated by 1-2 species and the number of fossils of other species are few, as shown below. Then the stratigraphic (chronological) transition of avifauna around Minatogawa is out of resolution if any. So the faunal discussion in this study targets the total birds as the Minatogawa paleoavifauna, though not a few fossil bones have respective grid record (Figure 2).

The systematics of birds follow the Ornithological Society of Japan (2012). The information on the recent habitat of birds referenced the ornithological books e.g. Amami Ornithologists' Club (1997) and Okinawa Yacho Kenkyu-kai (1993). The measurements of skeletal elements follow the measuring points and the term of Von den Driesch (1976).

SYSTEMATIC PALEONTOLOGY

Order COLUMBIFORMES
Family COLUMBIDAE
Genus *Treron*
Treron formosae
(Japanese name: Zuaka-aobato)

MATERIALS. 3 bones in Mb series: 1 almost complete right humerus (Mb0781, Plate 1-7), 1 proximal part of left scapula, 1 incomplete right tarsometatarsus.

MEASUREMENTS. Humerus: GL, 47.7 mm. Scapula: Dic, 9.5 mm. Tarsometatarsus specimen, no standard measurements possible, 22.2 mm as preserved.

COMPARABLE SPECIMENS. *Treron formosae*: the mounted

Table 1. Numbers of bones excavated from the Minatogawa Fissure. Numbers are the total added up from Mb and OMB series.

	Number of specimens	Humerus L	Humerus R	Ulna L	Ulna R	Radius L	Radius R	Carpo-metacarpus L	Carpo-metacarpus R	Sternum	Scapula L	Scapula R	Coracoid L	Coracoid R	Pelvis	Femur L	Femur R	Tibio-tarsus L	Tibio-tarsus R	Tarso-metatarsus L	Tarso-metatarsus R	Other elements	Minimum Number of Individuals
Treron formosae	3		1								1										1		1
Columbidae gen. et sp. indet.	3			2																1			2
Phalacrocorax capillatus	2													1			1						1
Nycticorax caledonicus	1	1																					1
Ardeidae gen. et sp. indet.	1																			1			1
Gallirallus okinawae	209	13	15	8	7			1	8	1	6	3	8	6	12	12	17	27	27	18	15	5	27
Porzana fusca	1		1																				1
Scolopax rusticola	1		1																				1
Scolopax mira ohyamai	571	44	37	27	16	7	15	19	29	23	25	20	34	38	16	14	11	33	28	34	31	70	44
Circus spilonotus	1																			1			1
Buteo buteo	1			1																			1
Otus lempiji	10	1	1									1				1		1	1	1	3		3
Garrulus lidthi	8	1		2								1						1		3			3
Corvus macrorh. connectens	4							2						1							1		1
Hypsipetes amaurotis	4	1		2										1									1
Zoothera major	3		1					1					1										1
Turdus pallidus	1																		1				1
Unidentified	210±	1		2						1								1		2	3	ca 200	-
Total	1034±	62	57	44	23	7	15	23	37	25	32	25	43	47	28	27	29	63	57	61	54	275±	91

skeleton in OPM; an osteological specimen in KUGM made from the body collected in Yanbaru, both sex unknown.

IDENTIFICATION. The almost complete humerus (Mb0781, Plate 1-7) is of medium-large sized dove, and identified to this species based on its overall slenderness. Other elements are referred to this species after the humerus revealed the existence of this species in Minatogawa assemblage.

NOTE. This pigeon prefers subtropical forests and is a common resident of the Ryukyu Archipelago today.

Genus and species indeterminate

MATERIALS. 3 bones in Mb series: 2 incomplete left ulnae, 1 shaft of left tarsometatarsus.

MEASUREMENTS. All fossils are fragmental and no standard measurements possible. Specimens are: ulna, 45.2 mm, 33.5 mm; tarsometatarsus, 26.7 mm, as preserved.

NOTE. These incomplete elements are the remains of at least one, or possibly more than two, of medium sized pigeons. Compared but not matched species for these fossils are: *Columba janthina*, *Streptopelia orientalis*, *Treron formosae*. One ulna could be a *Streptopelia orientalis*, but the tarsometatarsus is clearly not from this species.

Order SULIFORMES
Family PHALACROCORACIDAE
Genus *Phalacrocorax*
Phalacrocorax capillatus
(Japanese name: Umi-u)

MATERIALS. 2 bones in OMB series. OMB15, nearly complete right coracoid (Plate 1-3) and OMB16, nearly complete right femur (Plate 1-4).

MEASUREMENTS. Coracoid (OMB15): Lm, 75.5 mm. Femur (OMB16): Lm, 59.6 mm; cranio-caudal diameter of mid-shaft, 9.0 mm; lateral diameter of mid-shaft, 7.5 mm.

COMPARATIVE SPECIMENS. *P. capillatus*, *P. carbo hanedae*, *P. pelagicus pelagicus*, 2-5 individuals for each species in KUGM.

IDENTIFICATION. Both coracoid and femur are large and heavily build. Some continental subspecies of *P. carbo* is as large as, or larger than, the fossil materials. The overall characters of *P. capillatus*, however, are identical to the fossil materials.

NOTE. This cormorant is a winter visitor and/or a straggler in Okinawa today and comes to the waterside especially seacoast.

Order PELECANIFORMES
Family ARDEIDAE
Genus *Nycticorax*
Nycticorax caledonicus
(Japanese name: formally Hashibuto-goi, but is a bad name and then we give a new name, Akacha-goi, as mentioned below)

MATERIAL. Mb0135, the proximal end of left humerus (Plate 1-1).

MEASUREMENTS. No standard measurements possible. Specimen is 31.5 mm as preserved.

COMPARABLE SPECIMEN. *N. caledonicus caledonicus* (male), USNM-561542 (Plate 1-A).

IDENTIFICATION. Mb0135 is a fragmentary proximal portion of humerus. It lacks the tuberculum ventrale and other areas seriously, but is preserving important morphology for species identification. From the overall shape, it is identifiable as a *Nycticorax* species. The size is similar to *N. nycticorax*, a common species in Japan. It is, however, only *N. caledonicus* in which the detailed osteological characters such as well expanded bicipital surface, thick deltoid crest, deep and oval attachment of supraspinatus, and the vessel impression just

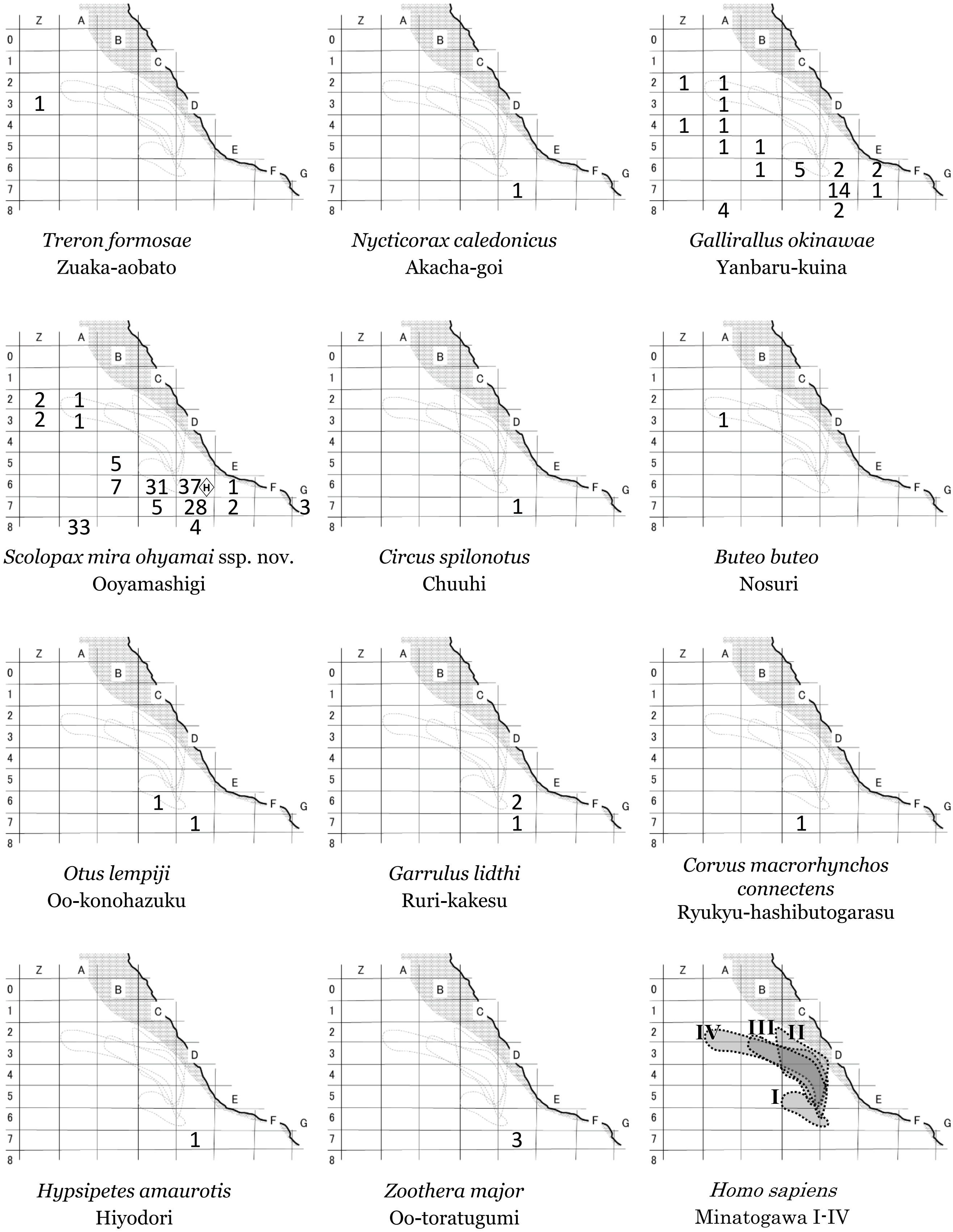


Figure 2. The grid information where the bones excavated. Each grids are 2 m for horizontal direction by 1 m for vertical direction. Numbers are the number of bones counted and catalogued from each grids. The 37 bones of *Scolopax mira ohyamai* ssp. nov. from the grid D-6 includes the holotype (Mb286). Area of the Minatogawa Man individuals (right bottom) is based on Hasegawa et al. (2007).

distal to the bicipital surface (arrowhead in Plate 1-A) are identical to the morphology of Mb0135. *N. nycticorax* never has the vessel impression just distal to the bicipital surface in its variation as far authors observed.

NOTE. This is the only record of *N. caledonicus* from Japan except an extinct (since 1889) endemic subspecies *N. c. crassirostris* of the Ogasawara (Bonin) Islands and a record of straggler on Hahajima, Ogasawara (Kawakami et al., 2015). *N. c. crassirostris* Vigors, 1839 is diagnosed by its thick and deep bill, thus the fossil is indeterminate for subspecies level.

We give a new Japanese name Akacha-goi for the species *N. caledonicus* here, because the currently used Japanese name Hashibuto-goi (Ornithological Society of Japan, 2012) is based on the peculiar character of the subspecies (Momiyama, 1930: "Hashibuto" means "stout bill", directly translated from "*crassirostris*") and thus not appropriate for the entire species. "Akacha" is the color "rufous", a specific characteristic of this heron.

Again, this heron has no record from the Ryukyu Islands as far ornithologists recorded. Today, this heron widely inhabit into the South Pacific islands, roosts and forges in mangrove-lined estuaries and feeds on tidal flats (Pratt et al., 1987).

Genus and species indeterminate

MATERIAL. Mb0271, the distal end of left tarsometatarsus (Plate 1-2).

MEASUREMENTS. No standard measurements possible. Specimen is 28.6 mm as preserved.

IDENTIFICATION. From the antero-posteriorly flattened tarsometatarsus with laterally arranged trochleas, it is identifiable to a heron. It is a small to medium sized heron. Compared but not matched species are: *Ardea cinerea jouyi*, *Nycticorax nycticorax*, *N. caledonicus caledonicus*, *Egretta garzetta*, *E. sacra*, *E. intermedia*, *Bubulcus ibis*. This tarsometatarsus is similar in size to it of *Egretta intermedia* within the compared seven species, but is still indeterminate to a certain species because of the characteristic robust trochlea for digit 2.

Order GRUIFORMES
Family RALLIDAE
Genus *Gallirallus*
Gallirallus okinawae
(Japanese name: Yanbaru-kuina)

MATERIALS. Totally 209 bones in Mb and OMB series. 201 bones in Mb series: 1 right quadrate; 14 right and 12 left humeri including some complete ones (e.g., Mb0160, Plate 2-5, an adult; Mb0159, Plate 2-11, an immature one; Mb0228, Plate 2-12, a very immature one); 7 right and 8 left ulnae (e.g., Mb0216, Plate 2-13; Mb0169, Plate 2-14); 8 right and 1 left carpometacarpi (e.g., Mb0043, Plate 2-15); 1 right phalanx proximalis digiti majoris (Mb0046, Plate 2-8); 1 fragment of sternum; 6 right and 8 left coracoids (e.g., Mb0065, Plate 2-7); 3 right and 6 left scapulae (e.g., Mb0252, Plate 2-6); 11 synsacrums (e.g., Mb0227, Plate 2-9; Mb0028, Plate 2-10); 2 coxas; 17 right and 11 left femora including some complete ones (e.g., Mb0241, Plate 2-18); 27 right and 26 left tibiotarsi (e.g., Mb0243, Plate 2-16; Mb0168, Plate 2-17); 1 right fibula; 15 right and 15 left tarsometatarsi (e.g., Mb0244, Plate 2-19; Mb0224, Plate 2-20) including 1 complete (Mb0244). 6 bones in OMB series: 1 right humerus, 1 left humerus, 1 synsacrum, 1 left femur, 1 left tibiotarsus, 1 left tarsometatarsus. The minimum number of individuals, calculated from the total of Mb and OMB series, is 27.

COMPARATIVE MATERIALS. *Gallirallus okinawae*, 2 in OPM, 1 male and 1 sex unknown, and 1 sex unknown in KUGM. Figure 3 was drown based on an OPM specimen. *G. torquatus* (NMNH-290445).

IDENTIFIFATION. *Gallirallus okinawae* has the skeleton heavily build as a rail (Figure 3). The morphology of fossil materials from Minatogawa are identical to the recent osteological specimens of *G. okinawae*. The volant ancestor of *G. okinawae* is presumed to be *G. torquatus* which is endemic to the Philippines and Indonesia (Yamashina and Mano, 1981). In comparison to *G. torquatus*, *G. okinawae* has: larger body; relatively wider and deeper cranium; lower but not completely lost carina on sternum; similar length but much fatter and thicker pectoral and fore limb elements (coracoid, humerus, ulna, radius, carpometacarpus and phalanx proximalis digits majoris); and much larger hind limb elements (femur, tibiotarsus and tarsometatarsus). The osteological comparison of *G. okinawae* and *G. torquatus* then gives clear distinctions between them.

NOTE. *Gallirallus okinawae* is an almost flightless rail and an endemic resident of the Yanbaru area, mountainy subtropical forests of the northern part of Okinawa Island. It prefers dense habitat near grassy and swampy areas. Now, the Minatogawa area, southern part of Okinawa Island is in the distance of some 70 km from the southern limit of the modern range of *G. okinawae*. The fossil record from Minatogawa indicates the full-island distribution of breeding *G. okinawae* at the Late Pleistocene.

The fossil bones identified to this species here is the "fossil rail" of Yamashina and Mano (1981) and "remains of at least one undescribed species of flightless rail of medium-large size" mentioned by Olson (1977, p.372). Though these notes on the fossil rail in Okinawa had some consideration that the "fossil rail" might be an ancestor of the modern species, now it is confirmed that the fossils from Minatogawa and the osteological specimens of modern *G. okinawae* are morphologically identical. Olson (1973) postulated that the needed time to evolve flightlessness in rails can be very short in geological sense. With the fossil record of *G. okinawae* from Minatogawa, it was settled that the timing of the arrival of the volant ancestor on Okinawa and the evolution of *G. okinawae* in Okinawa date back before the age of fissure-fill deposition of Minatogawa, an age we have no way to trace back in this study.

Many fossil bones of Mb series were used to make two reconstructed skeletons, one is on board and the other is in running posture. The one of running posture is in exhibition of the entrance hall of the natural history wing of Okinawa Prefectural Museum & Art Museum, in the dramatic scene of the Minatogawa Man skeleton going after to catch fossil animals.

Genus *Porzana*
Porzana fusca
(Japanese name: Hikuina)

MATERIAL. Mb0253, a complete right humerus (Plate 2-4).

MEASUREMENTS. Humerus: GL, 32.8 mm; Bp, 6.7 mm; Bd, 5.1 mm.

COMPARABLE SPECIMEN. *Porzana fusca* (male), USNM-319483.

IDENTIFICATION. The almost complete humerus (Mb0253, Plate 2-4) is of small rail, and identical to this species.

NOTE. It is an endemic subspecies *P. f. phaeopyga* Stejneger that is resident in the Ryukyu Islands. And a subspecies *P. f. erythrothorax* (Temminck and Schlegel) that breeds on eastern China and main islands of Japan (Kyushu and northward) also visits the Ryukyu Islands in winter. It is impossible to identify the fossil material to the subspecies level.

Order CHARADRIIFORMES
Family SCOLOPACIDAE
Genus *Scolopax*
Scolopax rusticola
(Japanese name: Yamashigi)

MATERIAL. OMB41, the distal potion of right humerus (Figure 4-D, Plate 3-1).

MEASUREMENTS. Specimen is 29.1 mm as preserved. Humerus: Bp, 9.9 mm; the major and minor axes of mid-shaft,

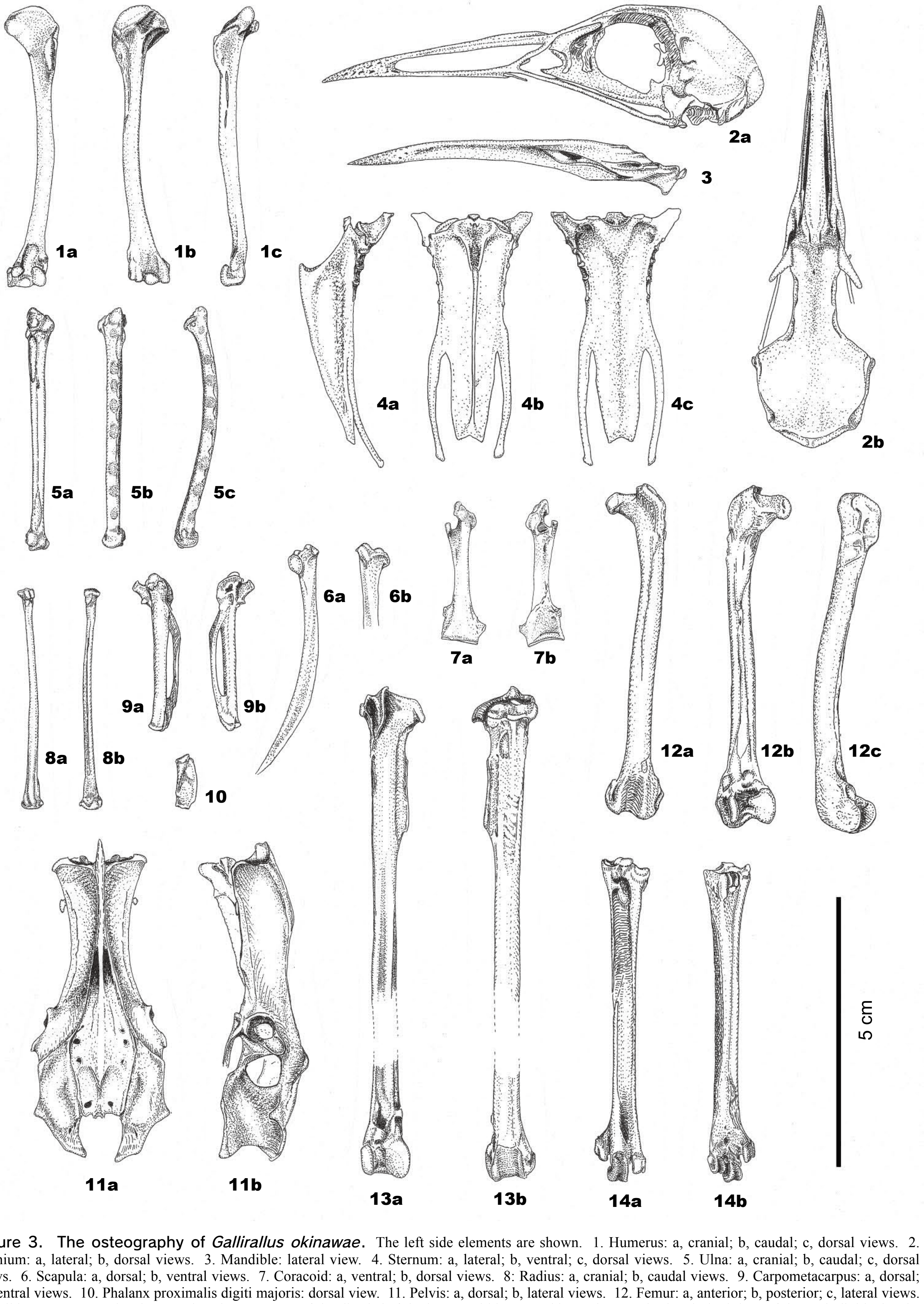


Figure 3. The osteography of *Gallirallus okinawae*. The left side elements are shown. 1. Humerus: a, cranial; b, caudal; c, dorsal views. 2. Cranium: a, lateral; b, dorsal views. 3. Mandible: lateral view. 4. Sternum: a, lateral; b, ventral; c, dorsal views. 5. Ulna: a, cranial; b, caudal; c, dorsal views. 6. Scapula: a, dorsal; b, ventral views. 7. Coracoid: a, ventral; b, dorsal views. 8: Radius: a, cranial; b, caudal views. 9. Carpometacarpus: a, dorsal; b, ventral views. 10. Phalanx proximalis digiti majoris: dorsal view. 11. Pelvis: a, dorsal; b, lateral views. 12. Femur: a, anterior; b, posterior; c, lateral views. 13. Tibiotarsus: a, anterior; b, posterior views. A part of the distal shaft is drown void because this portion was broken in both legs of drown individual. The lacking length was reconstructed from other specimen at a later time. 14. Tarsometatarsus: a, anterior; b, posterior views.

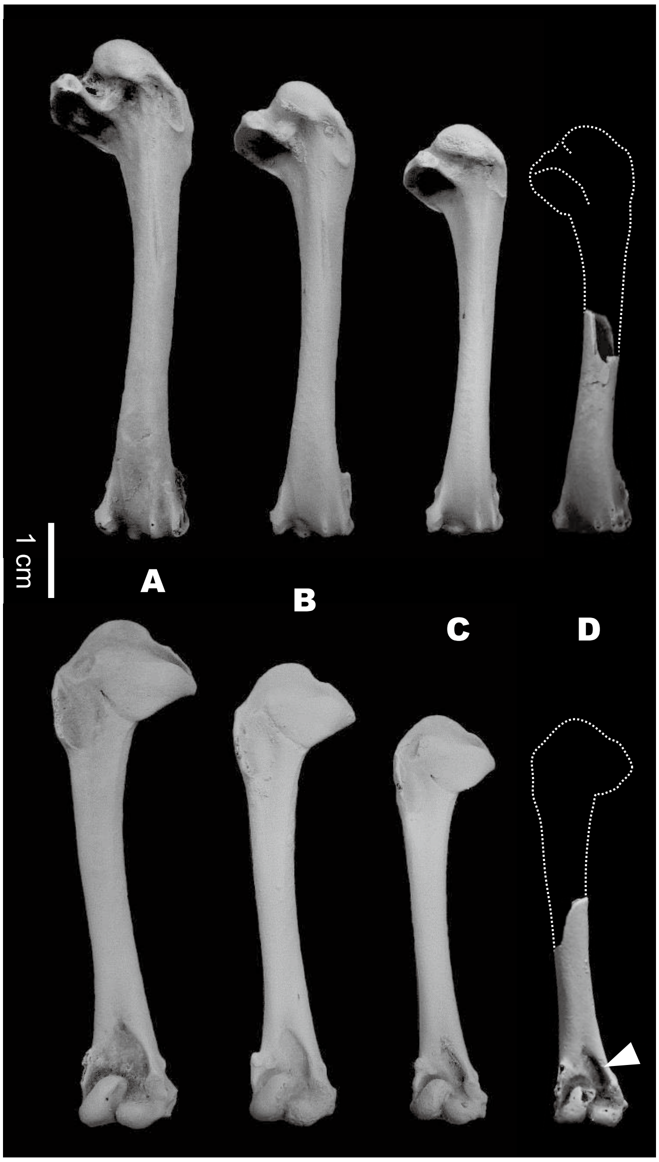


Figure 4. Comparison of *Scolopax* humeri. A. *Scolopax mira ohyamai* ssp. nov., a fossil from the Minatogawa Fissure. B. *Scolopax mira mira*, an osteological (recent) specimen collected in Amami-Oshima. C. *Scolopax rusticola*, an osteological (recent) specimen. D. OMB41, the distal portion of right humerus, a fossil from the Minatogawa Fissure, identified to *Scolopax rusticola*. Note the small size indicated by dotted line and narrow and deep Fossa m. brachialis (arrow head) of OMB41.

4.4 mm and 4.0 mm respectively.

COMPARATIVE MATERIAL. *Scolopax rusticola*, many in USNM, 1 in KUGM (Figure 4-C). Recent *S. mira* (Figure 4-B) and the fossils from Minatogawa (Figure 4-A, Plate 3-2 to 5).

IDENTIFICATION. The fossil material preserves only its distal portion. The overall shape is identical to *Scolopax*, and the size agrees to identify it to *S. rusticola* (Figure 4).

NOTE. Among the rich fossils of *Scolopax* from Minatogawa, this humeral piece is noticeably small. OMB41 is the only but significant evidence of *S. rusticola*, which was sympatric with *S. mira* in Okinawa Island.

Scolopax mira

(Japanese name: Amami-yamashigi)

SPECIFIC IDENTIFICATION. A large scolopacid whose osteological characters are identical to *Scolopax*. The hind limb elements are nearly identical to *S. mira*. The pectral and fore limb elements, on the other hand, are obviously larger than the recent *S. mira*. The rostrum, though the fossil materials are all fragmental, was also larger and thickly build than the recent *S. mira*. The difference between fossil materials and recent *S. mira* appears to be of species level. However, because no recent-population sized fossils of *S. mira* had been unearthed from Minatogawa, the fossils are referred to a fossil form, the chronological subspecies, of *S. mira*.

S. mira ohyamai ssp. nov.

(Japanese name: Ooyamashigi, new)

HOLOTYPE. Mb0286, complete right humerus, (Plate 3-2).

PARATYPES. Five paratypes are assigned. All are from the type locality, Minatogawa Fissure. Mb0644, rostrum piece, the basic part of naso-premaxillary (Plate 3-9); Mb0611, left coracoid,(Plate 3-13); Mb0312, complete left ulna (Plate 3-17); Mb0399, left carpometacarpus, lacking osmetacarpale minus (Plate 3-15); Mb0615, complete left tarsometatarsus (Plate 3-23).

MEASUREMENTS (mm). Humerus, right, Mb0286 (holotype): GL, 64.2; Bp, 16.7; Bd, 12.1; SC, 5.2; the minor axis of shaft measured at the point of SC (Dsc), 4.4. Humerus, left, Mb0288: GL, 68.8; Bp, 17.3; Bd, 12.3; SC, 5.6; Dsc, 4.3. Humerus, left, Mb0287: GL, 62.0; Bp, 16.5; SC, 5.0; Dsc, 4.5. Humerus, right, Mb0291: GL, 63.6; Bp, 16.8; Bd, 12.4; SC, 5.2; Dsc, 4.6. Ulna, left, Mb0312 (paratype): GL, 72.6; Dip, 10.7; Bp, 9.2; Did, 8.1; SC, 4.3. Carpometacarpus, left, Mb0332: GL, 43.9; Bp, 10.8; Did, 4.9. Coracoid, right, Mb0317: GL, 38.1; Lm, 32.0; BF, 8.3+. Coracoid, left, Mb0319: GL, 36.1; Lm, 34.1; BF, 8.9+. Coracoid, left, Mb0326: GL, 36.1; Lm, 33.6; BF, 9.4. Femur, left, Mb0339: GL, 52.2+; Lm, 51.4; Bd, 10.5; SC, 4.2; Dsc, 4.6. Tarsometatarsus, left, Mb0615: GL, 50.3; Bp, 9.2; Bd, 10.2; SC, 3.8. Data are shown in Figure 5.

ETYMOLOGY. Dedicated to the late Mr. Seiho Ohyama who rendered remarkable services to the paleontology and paleoanthropology of Okinawa. Discovery of the Pleistocene human fossils, Minatogawa-Man, from Minatogawa was the fruit of his ardor.

DIAGNOSIS. *Scolopax mira ohyamai* ssp. nov. is a fossil (chronological) subspecies of *S. mira*, characterized by its larger size than the recent population (*S. mira mira*). The wing elements are proportionally much larger than leg elements, and so *S. mira ohyamai* had a relatively developed wings compared with the recent *S. mira mira*. The length of main skeletal elements are, approximately, 108 % in humerus, 106 % in ulna, 107 % in carpometacarpus, 106 % in coracoid, 102 % in femur, 106 % in tibiotarsus, 102% in tarsometatarsus, of the average of the recent *S. mira mira*. *S. mira ohyamai* had the rostrum thickly build and whole skull was much larger compared with the recent *S. mira mira*.

TYPE LOCALITY. Minatogawa Fissure, Minatogawa, Yaese, the southern part of Okinawa Island, Japan.

STRATIGRAPHIC RANGE. Found from the Upper Pleistocene fissure-fill deposit of the Minatogawa Fissure. The fissure-fill deposits has radiocarbon age records of 18,250±650 and 16,600±300 BP (Suzuki and Tanabe, 1982), ca. 20,000-22,000 years ago. *S. mira ohyamai* changed the form to the recent subspecies *S. mira mira* and does not exist today. The timing of morphological shift is not known. But, the large number of fossils from Minatogawa that originated from grid to grid in excavations (Figure 2) indicate rapid transition from *S. mira ohyamai* to *S. mira mira* occurred in very recent past.

REFERRED SPECIMENS. Totally 571 bones including holotype and paratypes in Mb and OMB series (Plate 3-2 to 24). 545 fossilized bones including holotype and paratypes in Mb series: 36 right humeri, 39 left humeri, 15 right ulnae, 24 left ulnae, 8 right radii, 7 left radii, 29 right carpometacarpi, 19 left carpometacarpi, 5 right phalanxes proximalis digiti majoris, 4 left phalanxes proximalis digiti majoris, 23 sternum fragments, 37 right coracoids, 33 left coracoids, 19 proximal fragments of right scapula, 24 proximal fragments of left

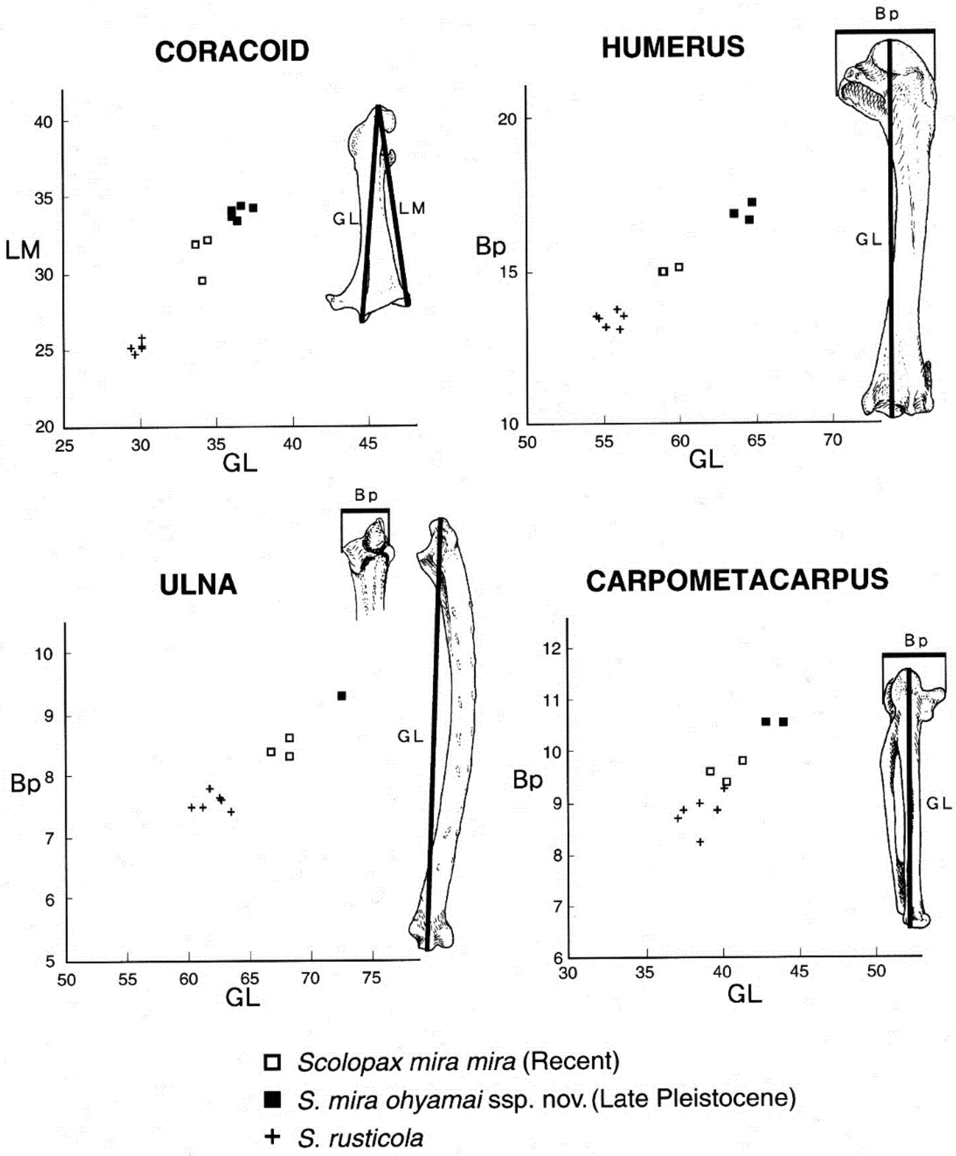


Figure 5. Bivariate scatter plots of *Scolopax* skeletal elements. Measurements in millimeters.

scapula, 15 synsacrums, 12 right femora, 10 left femora, 26 right tibiotarsi, 28 left tibiotarsi, 31 right tarsometatarsi, 33 left tarsometatarsi, and 68 other minor skeletal elements. 25 bones in OMB series: 1 right humerus, 5 left humeri, 1 right ulna, 3 left ulnae, 1 right coracoid, 1 left coracoid, 1 right scapula, 1 left scapula, 1 synsacrum, 1 right femur, 2 left femora, 2 right tibiotarsi, 5 left tibiotarsi, 1 left tarsometatarsus. The minimum number of individuals, calculated from the total of Mb and OMB series, is 44.

DESCRIPTION. It is obvious that the fossils are of *Scolopax* species. Fossil elements are large, and look alike of *S. mira*. However, not only the holotype humerus (Mb0286), *Scolopax* fossils of type locality Minatogawa are commonly larger than the osteological specimens of recent *S. mira*, especially in the particular elements. Figure 5 shows the measurements. Though the data are scanty in both fossil and recent birds because most of the fossil bones are broken and Amami Woodcock is a rare bird today, the difference between the fossils and recent *S. mira* is almost equal to the difference between *S. rusticola* and *S. mira*.

Also, the large quantity of fossil material allows us to reconstruct the original morphology for each skeletal elements (Figures 6 and 7). The measured and reconstructed length of main skeletal elements are, approximately, 108 % in humerus, 106 % in ulna, 107 % in carpometacarpus, 106 % in coracoid, 102 % in femur, 106 % in tibiotarsus, 102% in tarsometatarsus, of the average of the recent *S. mira*. It is important that the wing elements are proportionally larger than the leg elements. The femur and tarsometatarsus do not have clear size differences, only 2 % larger, in contrast to the recent *S. mira*.

The skull and mandible of fossil form appear to be much proportionally larger. A paratype Mb0644, the basic part of naso-premaxillary of rostrum is remarkably robust (Plate 3-9). Cranium (Plate 3-6) is built thickly. Quadrate (Plate 3-7), lower mandible portions (Plate 3-11, 12), and fragments of rostrum (e.g., Plate 3-10) are large and solid. The estimated size of whole skull of fossil woodcock reaches as larger as 125 % of recent *S. mira* (Figure 7). A big-headed appearance of the fossil bird is probable.

Some specimens are incompletely ossified (Plate 3-4, 5), which indicate the breeding status of this bird on the southern part of Okinawa at the Late Pleistocene.

NOTE. The morphological difference between the fossil form and recent *Scolopax mira* is definitely a species-level. But, the Minatogawa fissure-fill deposits do not yield the recent-sized

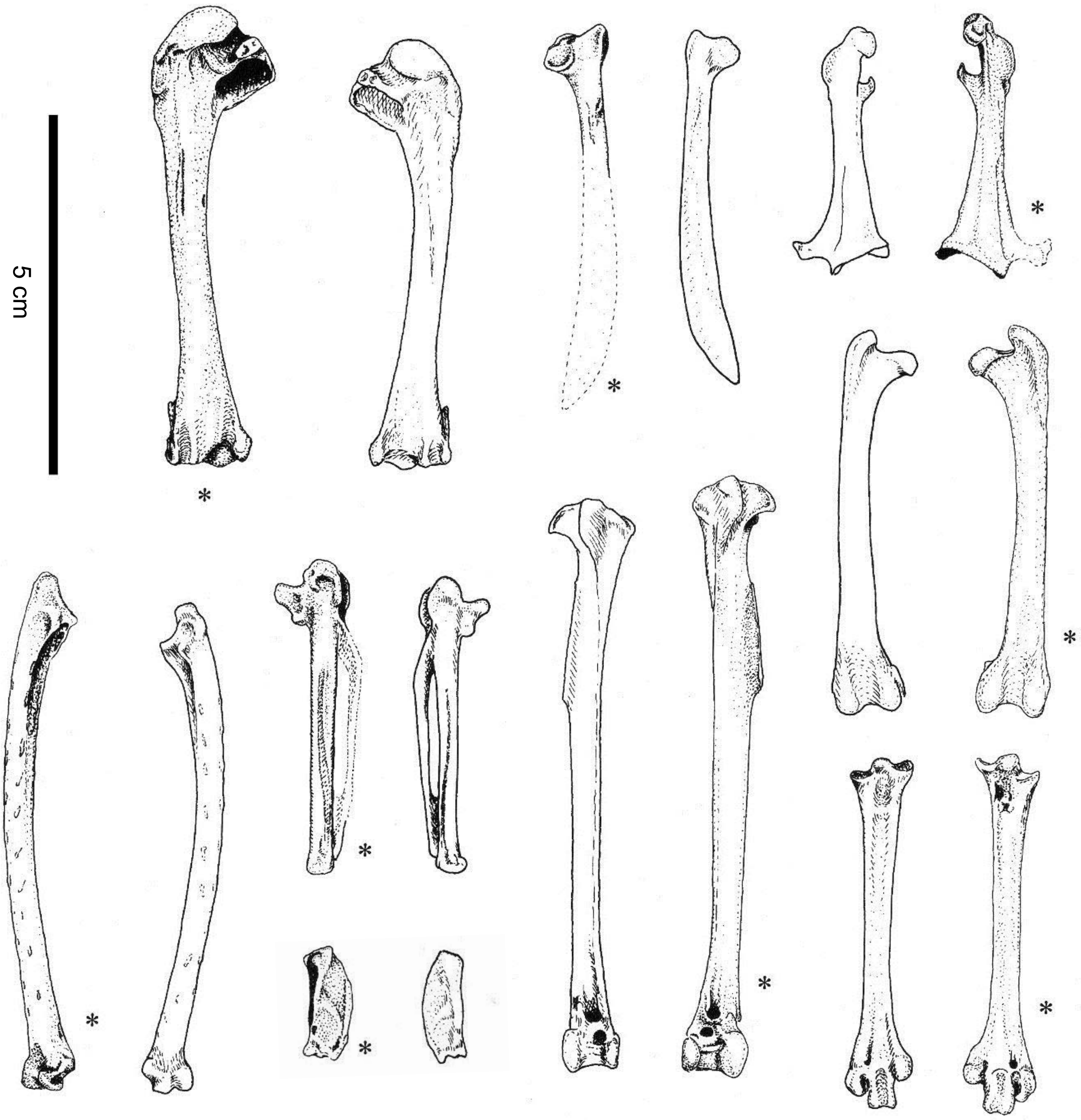


Figure 6. The osteography comparing *Scolopax mira ohyamai* ssp. nov. with recent *S. mira mira*. The left side bones with asterisk are of *Scolopax mira ohyamai* ssp. nov., and the right side bones, which are commonly smaller than the fossil form, are of *S. mira mira*.

wing elements of *Scolopax mira*. *Scolopax rusticola*, on the contrary, has its fossil occurrence (OMB41) from Minatogawa as above noted. The simple conclusion of such situation is to regard the fossil form as the chronological subspecies: the fossil form and the recent form are under the chronological allopatry. We therefore establish a new subspecies for the fossil form and name *Scolopax mira ohyamai*.

Recent *S. mira mira* is endemic in the Central Ryukyu Islands. It breeds only on Amami-Oshima, wherein common in evergreen forests and sugar cane fields. It migrates south in winter and appears on Yambaru of Okinawa Island and adjacent islands, but does not breed in these southern islands of its range. Fossil subspecies *S. m. ohyamai*, on the other hand, has the evidence of breeding in Minatogawa, the southern end of Okinawa Island. Fossil *S. mira* (subspecies unknown in this study) is recorded from the Pinza-abu Cave of Miyako Island (Matsuoka, 2000). *S. m. ohyamai* had relatively wing-developed proportion. It could be hypothesized that *S. m. ohyamai*, which was a powerful flier and had wide range, had to be evolved to the smaller *S. m. mira* at the glacial-postgracial transition.

Fossils of *S. m. ohyamai* originated throughout the excavation grids (Figure 2). That means, though the deposition system was not simple in the Minatogawa fissure fill deposits (Hasegawa et al., 2017), it must took long time of hundreds to thousands years order. However, all *S. mira* fossils of Minatogawa are uniform in size, with no relation to the stratigraphic revel. This fact may indicates the morphological stability for the avian chronological subspecies. *S. m. ohyamai* kept its wing-developed proportion for long years, and after the transition, the chronologically younger *S. m. mira* has also its own proportion with small variation today. Quick and punctuational transition from *S. m. ohyamai* to *S. m. mira* is expected. *Scolopax mira* could be a good example to show the punctuated equilibrium model for the morphological transition in avian species if the Holocene records grown up.

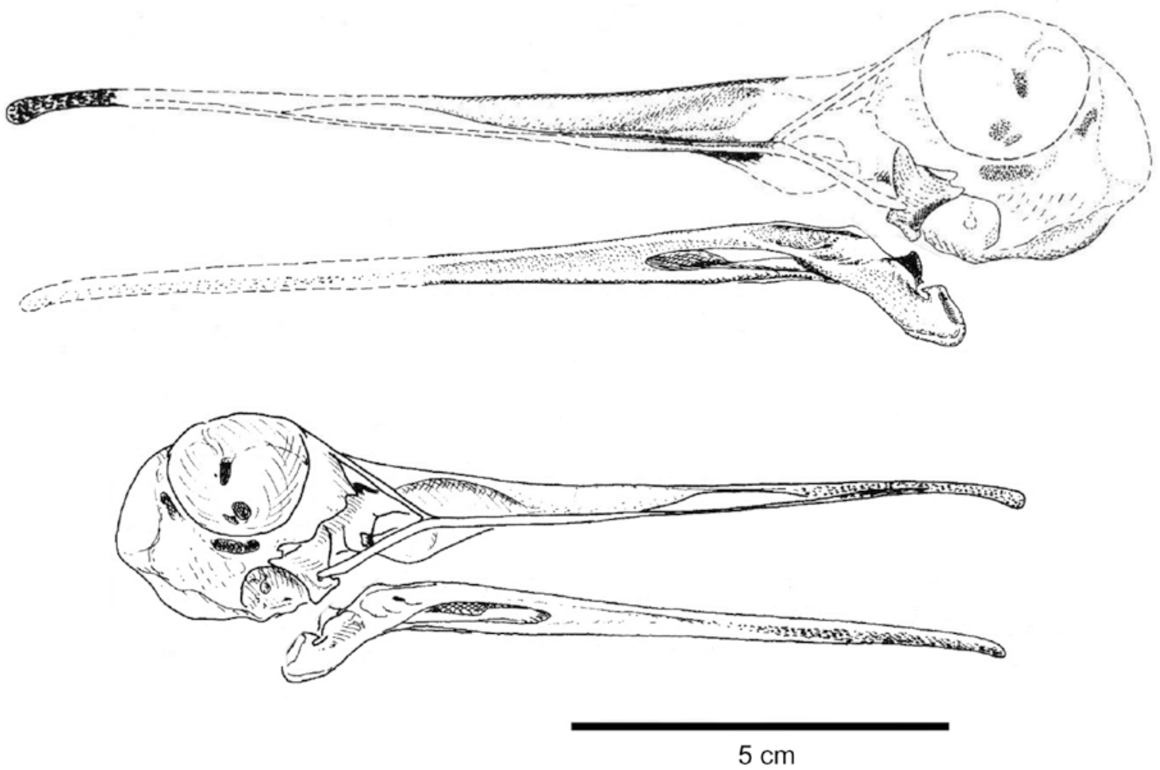


Figure 7. The reconstructed skull and mandible of *Scolopax mira ohyamai* ssp. nov. (above) and the skull and mandible of recent *S. mira mira* (below).

Order FALCONIFORMES
Family ACCIPITRIDAE
Genus *Circus*
Circus spilonotus
(Japanese name: Chuuhi)

MATERIAL. Mb0145, the distal portion of left tarsometatarsus (Plate 1-5).

MEASUREMENTS. No standard measurement possible. Specimen is 47.5 mm as preserved.

COMPARATIVE MATERIALS. *Circus aeruginosus* (male) USNM-557495. Following species were also compared in USNM: *C. approximans*, *C. cyaneus hudsonius*, *C. melanoleucus*.

IDENTIFICATION. The overall shape of fossil material is almost identical to the compared *Circus aeruginosus* specimen.

Formerly, *Circus aeruginosus* and *C. spilonotus* (and more relatives) were included in single species *C. aeruginosus* (Ornithological Society of Japan, 2012). We could not examine the osteological specimen of Eastern marsh harrier (*C. spilonotus*), and the fossil is slightly larger than compared specimen of male *C. aeruginosus* collected at Azerbaijan (USNM-557495). More specimens, strictly speaking, are needed to determine the specific identification for this tarsometatarsus, but we are clear to identify the fossil to this common species of Japan.

NOTE. *Circus spilonotus* is a rare winter visitor in Ryukyu, while it is a common winter visitor in Kyushu and northward and breeds in northern Japan (Takano, 1994).

Genus *Buteo*
Buteo buteo
(Japanese name: Nosuri)

MATERIAL. Mb0146, the distal portion of left ulna (Plate3-6).

MEASUREMENTS. No standard measurements possible. Specimen is 38.4 mm as preserved.

COMPARABLE MATERIAL. *Buteo buteo*, 1 KUGM.

IDENTIFICATION. The fossil material is fragmental, but identifiable to a medium-sized accipitrid. The overall shape is identical to *Buteo buteo*.

NOTE. *Buteo buteo* is a winter visitor in the islands of Ryukyu (Takano, 1994).

Order STRIGIFORMES
Family STRIGIDAE
Genus *Otus*
Otus lempiji
(Japanese name: Oo-konohazuku)

MATERIALS. 10 skeletal elements in Mb series and 1 in OMB series: 1 right humerus (Mb0134, Plate 1-8), 1 left humerus, 1 right scapula (Mb0113, Plate 1-11), 1 left coracoid (OMB42, Plate 1-12), 1 left femur (Mb0124, Plate 1-13), 1 right tibiotarsus, 1 left tibiotarsus (Mb0147, Plate 1-14), 1 right tarsometatarsus (Mb0138, Plate 1-9), 3 left tarsometatarsi (e.g. Mb0139, Plate 1-10).

COMPARATIVE MATERIAL. *Otus lempiji semitorques*, 2 KUGM, one from Kyoto City and one from Hakusan City, Ishikawa Prefecture, Japan (both in Honshu Island).

IDENTIFICATION. The fossil materials are fragmental, but identifiable to a small-sized strigid, and are totally identical in shape and size to the specimens of *O. l. semitorques*. Then we identify the fossils to this species, though we could not investigate the osteology of *Otus lempiji pryeri*.

NOTE. An endemic subspecies *Otus lempiji pryeri* lives in the Okinawa Islands and Southern Ryukyu Islands.

Order PASSERIFORMES
Family CORVIDAE
Genus *Garrulus*
Garrulus lidthi
(Japanese name: Ruri-kakesu)

MATERIALS. 8 skeletal elements, 7 in Mb series and 1 in OMB series. Mb0128, the shaft of left humerus; Mb0131, a left ulna lacks only the both ends (Plate 2-2); Mb0129, the distal portion of left ulna; Mb0132, a right scapula (Plate 2-1);

Mb0128, the shaft of left tibiotarsus; Mb0141, the proximal end of left tarsometatarsus; OMB43, the proximal portion of left tarsometatarsus (Plate 2-3); Mb0130, the distal portion of left tarsometatarsus.

MEASUREMENTS. Specimens are: Mb0128, 19.5 mm; Mb0131, 38.2 mm; Mb0129, 20.0 mm; Mb0132, 18.3 mm; Mb0128, 17.3 mm; Mb0141, 11.3 mm; OMB43, 17.7 mm; Mb0130, 19.1 mm, as preserved. The width of proximal end of tarsometatarsus, 6.7 mm (measured in OMB43).

COMPARATIVE MATERIALS. *Garrulus lidthi* collected in Amami-Oshima, 1 in KUGM. *Garrulus glandarius* collected in Kyoto, 1 in KUGM. The ulnae and tarsometatarsi of both species, with a tarsometatarsus of *Corvus macrorhynchos osai* as a reference, are shown next to the fossils (Plate 2-A to E).

IDENTIFICATION. Fossil materials are identical to *Garrulus*. In comparison between *G. lidthi* and *G. glandarius*, the bones of *G. lidthi* is larger and proportionally robust in general. The nearly complete ulna (Mb131) is certainly identical to *G. lidthi*. Based on the shape of caudal margin of ulna in dorso-ventral aspect: it is moderately rounded in *G.lidthi*, and the appearance is different from *G. glandarius* that is much straight (white broken lines of Plate 2-A and B). On tarsometatarsus, some characters in anterior view are useful to distinguish *G. lidthi* from *G. glandarius*: sulcus extensorius locates medially; the distal end of tuberositas m. tibialis cranialis (arrowhead on Plate 2-C) is wide and developed; the medial margin of proximal end (dot line on Plate 2-C) is parallel to the long axis of bone.

NOTE. *Garrulus lidthi* is a world-famous endemic bird of Amami Islands. It is endemic only in Amami-Oshima and the adjutant isles today, with historical range in Tokuno-shima Island. Lives and nests in the evergreen forests, normally arboreal and occasionally feeds on the ground.

Together with the case of *Zoothera major*, fossils from Minatogawa revealed the wider distribution of this endemic bird, covering whole Central Ryukyu Islands at the Late Pleistocene.

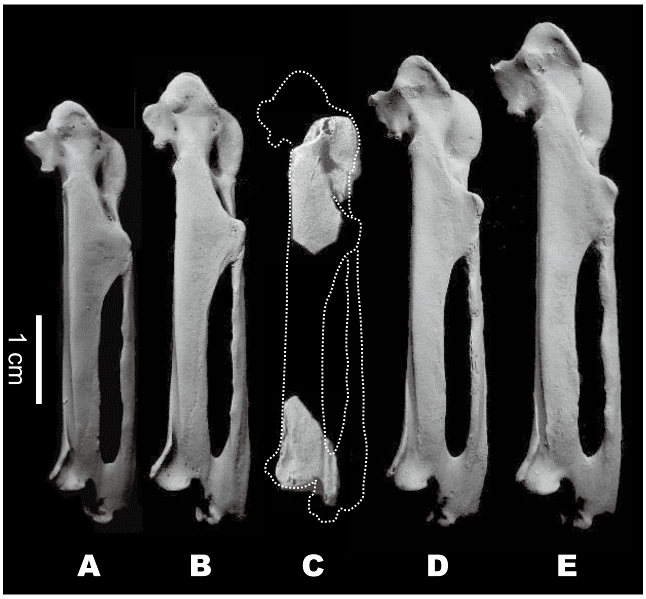


Figure 8. The comparison of *Corvus* carpometacarpi. The dorsal view of left carpometacarpi. A. *Corvus macrorhynchos osai* collected in Iriomote Island. B. *C. macrorhynchos connectens* collected in Amami-Oshima Island. C. Mb0121 (proximal fragment) and Mb0122 (distal fragment) from the Minatogawa Fissure, and the size reconstruction of these fossils (dotted line). D. A small example of *Corvus macrorhynchos japonensis*, an individual collected in Kyoto. E. A largest individual of *Corvus macrorhynchos japonensis*, collected in Shinjuku, Tokyo. Note that, though fragmentary, the fossils match up to *C. macrorhynchos connectens*.

Genus *Corvus*

Corvus macrorhynchos connectens

(Japanese name: Ryukyu-hashibutogarasu)

MATERIALS. 4 fragments, 2 in Mb series and 2 in OMB series. OMB45, the cranial portion of right coracoid (Plate 1-16); Mb0121, Mb0122, 2 pieces of left carpometacarpus (Figure 8-C, Plate 1-18, Plate 1-19); OMB46, the distal portion of right tarsometatarsus (Plate 1-17).

MEASUREMENTS. No standard measurements possible. Specimens are: 15.3, 12.7, 28.5, and 31.3 mm for Mb, Mb, Mb, and Mb, respectively.

COMPARATIVE MATERIALS. *Corvus macrorhynchos japonensis*, many in KUGM, two carpometacarpi, one of the largest and a small example in the collection, are shown in Figure 8-D, E. *C. macrorhynchos connectens*, 3 in KUGM, collected in Amami-Oshima Island, a carpometacarpus is shown in Figure 8-B. *C. macrorhynchosc. osai*, 1 in KUGM, collected in Iriomote Island, a carpometacarpus is shown in Figure 8-A.

IDENTIFICATION. The fossil materials are fragmentary, but identifiable to a small *Corvus*. Though fragmentary, the size exactly fit to *C. m. connectens* (Figure 8), and we identify fossils to this subspecies.

NOTE. Though they are quite fragmentary, the fossils from Minatogawa are identifiable to *C. m. connectens*. This subspecies is endemic to the Central Ryukyu Islands, and shows allopatric distribution to *C. m. japonensis* of main-islands of Japan. Hasegawa et al. (1978), in contrast, reported *C. macrorhynchos* from the Gohezu cave of Ie Island. The fossils of Gohezu is stunningly large and they are identical to *C. m. japonensis*. Now we may have two hypotheses on the evolution and taxonomy of *connectens*. One is the possibility of rapid subspeciation from large *japonensis*-type population to smaller *connectens*, occurred after the age of Gohezu and before the age of Minatogawa. And the other possibility is the sympatric coexistence of *japonensis* and *connectens* in the Late Pleistocene on Okinawa Island, with a story that the recent allopatric ranges of jungle crows, *japonensis* in northern main islands of japan and *connectens* in Ryukyu, is a superficial pattern caused through the disappearance of *japonensis* from Ryukyu. Further research is needed on this problem.

Family PYCNONOTIDAE

Genus *Hypsipetes*

Hypsipetes amaurotis

(Japanese name: Hiyodori)

MATERIALS. 4 bones in Mb series: the shaft of left humerus, the shaft of left ulna, the distal portion of left ulna, the cranial portion of right coracoid (Mb0784, Plate 1-15).

COMPARATIVE MATERIALS. *Hypsipetes amaurotis*, many in KUGM: many *Hypsipetes amaurotis amaurotis* (Honshu and Kyushu individuals), 1 *H. a. pryeri* (collected in Okinawa), 1 *H. a. stejnegeri* (collected in Ishigaki).

IDENTIFICATION. From the overall shape and size, fossil materials are identified to *Hypsipetes amaurotis.*

NOTE. *Hypsipetes amaurotis* is an abundant resident in Okinawa and living light woods and forests of mountains to lowland. This species is divided into many subspecies. In the Ryukyu Archipelago, *H. a. ogawae* of the Amami Islands, *H. a. pryeri* of the Okinawa and Miyako islands, *H. a. stejnegeri* of the Yaeyama Islands, and *H. a. nagamichii* of Yonaguni and Taiwan islands are the endemic subspecies. In addition, *H. a. hensoni* the resident of Hokkaido and *H. a. amaurotis* of the other main islands migratory visit the islands of Ryukyu. They mainly depend on the darkish coloring, and are not unique for the osteology. So it is impossible to identify the Late Pleistocene fossils to the subspecies.

Family MUSCICAPIDAE

Genus *Zoothera*

Zoothera major

(Japanese name: Oo-toratugumi)

MATERIALS. Three bones in Mb series: Mb0127, the shaft of left humerus (Plate 1-23); Mb0786, an almost complete left coracoid (Plate 1-22); Mb0126, the distal portion of right carpometacarpus (Plate 1-21).

MEASUREMENTS. Specimen length as preserved are 28.5, 32.0, and 14.8 mm for Mb0127, Mb0786, and Mb0126, respectively. The specimen length of Mb0786, coracoid, is equal to Lm of Von den Driesch (1976).

COMPARATIVE MATERIALS. *Zoothera major*, 1 in KUGM (Plate 1-C, D, E) from Amami-Oshima Island. *Zoothera dauma*, 5 in KUGM, all from Honshu Island.

IDENTIFICATION. Fossil materials are of large thrush. The almost complete left coracoid (Mb0786, Plate 1-22) and the distal portion of right carpometacarpus (Mb0126, Plate 1-21) are identical to *Zoothera major* (Plate 1-C and D) in shape and size. The skeleton of *Z. major* is obviously larger and strongly build than *Z. dauma* and the difference can never be the intraspecific one. The humerus lacking both ends (Mb0127, Plate 1-23) is not characteristic enough to identify definitely.

NOTE. We treat this bird as a full-species, though the Ornithological Society of Japan (2012) regards this as a subspecies *Zoothera dauma major*. *Zoothera major* is endemic to the Amami-Oshima, and adjutant isles possibly, of the Amami Islands only today. The fossil occurrences from Minatogawa, Okinawa and Miyako Island (Matsuoka, 2000) attest to the great shrinkage of forest avifauna after the Late Pleistocene.

Genus *Turdus*

Turdus pallidus

(Japanese name: Shirohara)

MATERIAL. OMB44, the distal portion of right tibiotarsus (Plate 1-20).

MEASUREMENTS. Specimen is 20.2 mm as preserved. The breadth of distal end is 3.7 mm.

COMPARATIVE MATERIAL. *Turdus pallidus*, 1 in KUGM (Plate 1-B).

IDENTIFICATION. From the overall shape and size, fossil material is identical to *Turdus pallidus*.

FEATURES OF MINATOGAWA PALEOAVIFAUNA

1) As the evidence of developed forest in the Late Pleistocene southern part of Okinawa Island, with a comment on the taphonomy of fossil assemblage

It is possible to summarize Minatogawa avian fossil assemblage as a paleoavifauna consists mainly of forest-ground dwellers. *Scolopax mira* and *Gallirallus okinawae*, two species whose fossil bones occupy nearly 95% of the number of Minatogawa avian fossil assemblage, are typical ground dwellers living in forest and walk around to find foods with their developed legs. Other species, *Treron formosae*, *Porzana fusca*, *Scolopax rusticola*, *Otus lempiji*, *Garrulus lidthi*, *Corvus m. connectens*, *Hypsipetes amaurotis*, *Zoothera major*, and *Turdus pallidus* have also the lifestyle prefer forest. Only *Phalacrocorax capillatus*, *Nycticorax caledonicus*, *Circus spilonotus*, and *Buteo buteo* are somewhat extraneous to call forest dweller, but still nest or hunt in forest and then have relation to forest.

Today the Minatogawa Fissure locates close to sea coast and the terrace surface is only 20 m or so above sea. It was, however, at around the Last Glacial Maximum stage when deposits filled the fissure and the sea level regressed more than 100 m (Suzuki and Tanabe, 1982). Then the ground surface fissured by the Minatogawa Fissure was at roughly 120 m or more above sea in that age, with wide land sloping to coastline in south. Such hilly geography is suited to be developed by vegetation. The Minatogawa Paleoavifauna must have formed in a forest, which was like the one in today's Yanbaru and Amami islands.

Geologically, the Minatogawa Fissure is a tectonic fissure appeared in the terrace surface. Ground was developed by vegetation. What would happen in such dangerous situation for ground dwellers? It was a natural pitfall, wasn't it? Actually, the avian fossil assemblage show characters that are consistent with "pitfall hypothesis": dominant fossil occurrence of forest-ground dwellers; the characteristic mode of fossil occurrences of *Scolopax mira* and *Gallirallus okinawae* which includes many fossils of fragile parts such as skull elements as well as the durable long bones; and lack of preyed, scavenged and/or weathered evidence on the bones. The Minatogawa Man bodies were assumed to be thrown into the fissure by other people after the death of illness (Hasegawa et al., 2017). Non-human animals on the other hand seems to be trapped and fall into the fissure, a natural pitfall, one after another.

2) As a key to see the Yanbaru and Amami-Oshima endemism

The Late Pleistocene forest around Minatogawa, the southern part of Okinawa Island must have connected to the Yanbaru, the northern part of Okinawa, and Amami Islands across the straits to the north zoogeographically, because all endemic birds of the Central Ryukyu Islands, *Gallirallus okinawae*, *Scolopax mira*, *Garrulus lidthi* and *Zoothera major*, except for a woodpecker *Sapheopipo noguchii* of Yanbaru, are included in the fossil assemblage of the Minatogawa Fissure. But the avifauna today shows patchy patterns, "per island" in general: *Garrulus lidthi* and *Zoothera major* distribute only in Amami-Oshima and adjacent isles, *Scolopax mira* breeds only on the Amami Islands though some of them migrate into the islands around Okinawa in winter, and *Gallirallus okinawae* inhabit only in Yanbaru.

What would be a cause of such faunal fragmentation?

Paleontological investigations on insular birds, which increased explosively in recent years, have repeatedly shown that the early human activity had left extremely adverse effects on island ecosystems world-widely (e.g. Cassels, 1984; Olson and James, 1984; Steadman, 1995). Now we know that the resulting extinctions or extirpations of populations have produced completely unnatural faunal assemblages that are grossly misleading with regard both to species diversity and zoogeographical patterns of islands (Olson, 1990).

The paleoavifauna of the Minatogawa Fissure, which was with *Homo sapiens* Minatogawa Man, conflicts to the view of human-caused extirpation of birds in Okinawa. If humans were criminal for the local extinction of birds, it might be by the post-Minatogawa-Man generation. We do not know why and when it occurred. But, it is certain we must take our remark to heart that the existing state of the forests of Yanbaru and Amami are truly like the "Noah's ark". These forests should be preserved with special consciousness.

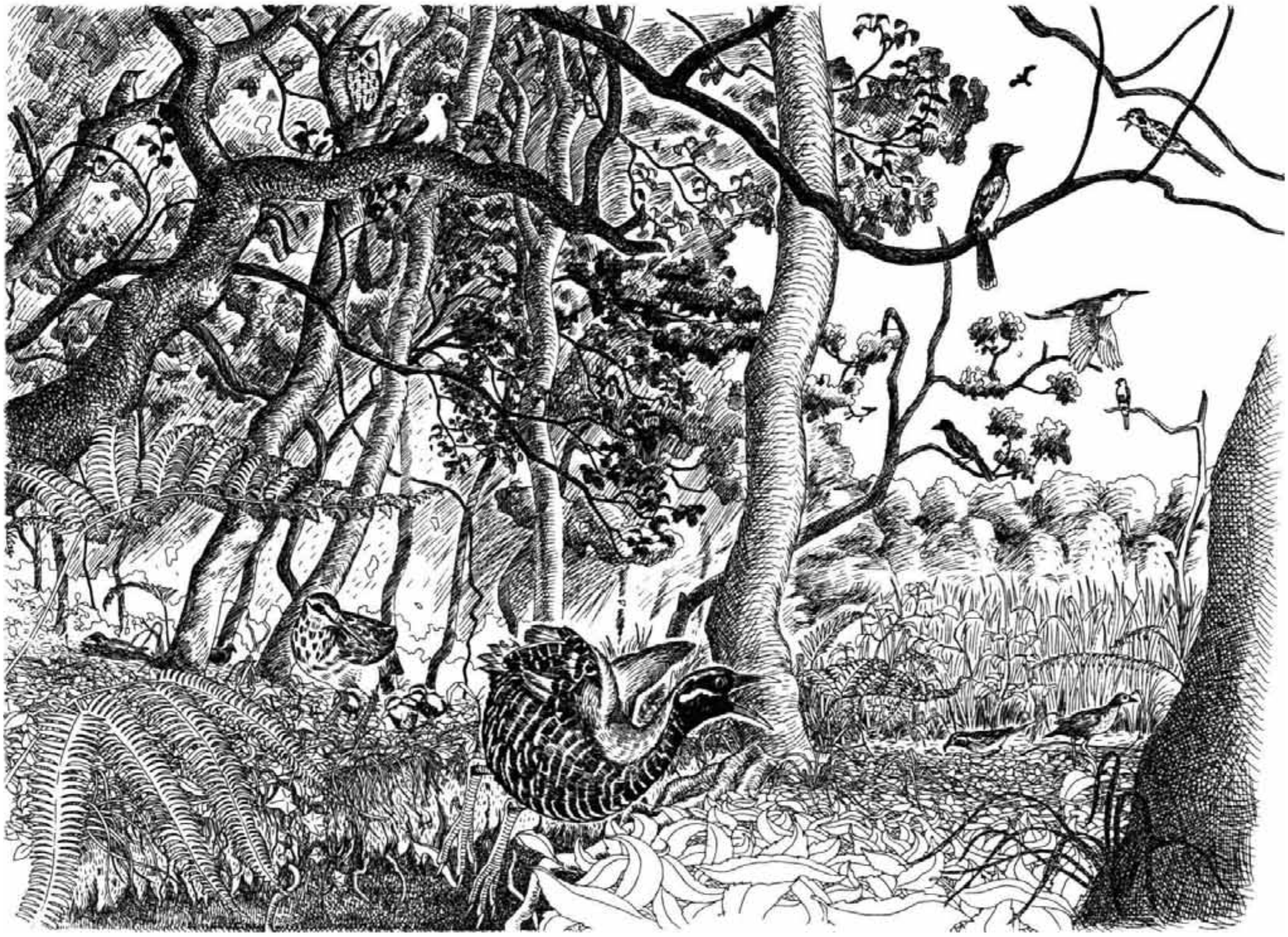
CONCLUSION

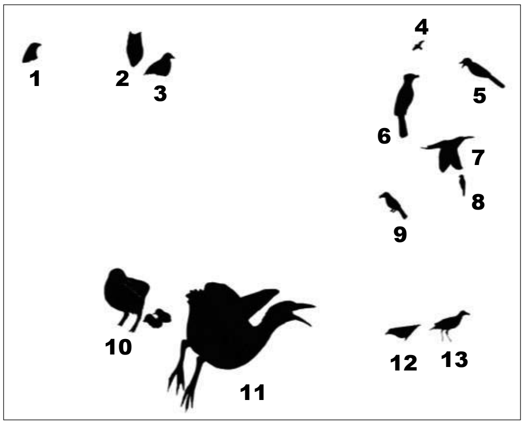
The avian fossil assemblage of the Minatogawa Fissure, the locality of the Late Pleistocene *Homo sapiens* Minatogawa Man fossils, Minatogawa, Yaese Town, the southern part of Okinawa Island consists of 17 species belonging to 10 families of 8 orders. They are listed as below. The word in brackets is the Japanese name.

Columbiformes
- Columbidae
  - *Treron formosae* [Zuaka-aobato]
  - Gen. et sp. indet.

Suliformes
- Phalacrocoracidae
  - *Phalacrocorax capillatus* [Umi-u]

Pelecaniformes
- Ardeidae
  - *Nycticorax caledonicus* [Akacha-goi]





1 *Zoothera major* [Oo-toratugumi]
2 *Otus lempiji* [Oo-konohazuku]
3 *Treron formosae* [Zuaka-aobato]
4 *Circus spilonotus* [Chuuhi]
5 *Hypsipetes amaurotis* [Hiyodori]
6 *Garrulus lidthi* [Ruri-kakesu]
7 *Nycticorax caledonicus* [Akacha-goi]
8 *Buteo buteo* [Nosuri]
9 *Corvus m. connectens* [Ryukyu-hashibutogarasu]
10 *Scolopax mira ohyamai* [Ooyamashigi]
11 *Gallirallus okinawae* [Yanbaru-kuina]
12 *Turdus pallidus* [Shirohara]
13 *Porzana fusca* [Hikuina]
not in image *Phalacrocorax capillatus* [Umi-u]
Scolopax rusticola [Yamashigi]

Figure 9. An artist's drawing reconstructed the paleo-scenery of Minatogawa. Artwork by Mr. Yuichi Kitamura.

Gen. et sp. indet.
Gruiformes
Rallidae
Gallirallus okinawae [Yanbaru-kuina]
Porzana fusca [Hikuina]
Charadriiformes
Scolopacidae
Scolopax rusticola [Yamashigi]
Scolopax mira ohyamai ssp. nov. [Ooyamashigi]
Falconiformes
Accipitridae
Circus spilonotus [Chuuhi]
Buteo buteo [Nosuri]
Strigiformes
Strigidae
Otus lempiji [Oo-konohazuku]
Passeriformes
Corvidae
Garrulus lidthi [Ruri-kakesu]
Corvus macrorhynchos connectens [Ryukyu-hashibutogarasu]
Pycnonotidae
Hypsipetes amaurotis [Hiyodori]
Muscicapidae
Zoothera major [Oo-toratugumi]
Turdus pallidus [Shirohara]

The insular fauna of the Ryukyu Archipelago is highly unique. Through the paleontological investigation of the fossil records of animals, the ecological importance of the forests of Yanbaru (the northern part of Okinawa Island) and Amami-Oshima Island is coming much clear. The fossils of the endemic birds of Amami from Minatogawa is the evidence of forest environment once covered the whole islands of central Ryukyu in Late Pleistocene. Moreover, the forest was protective of all endemic birds of Central Ryukyu Islands in that age. *Garrulus lidthi*, *Zoothera major*, and *Scolopax mira* which are endemic in Amami, and *Gallirallus okinawae* living only in Yanbaru are all fossilized in Minatogawa. Later extirpation in the southern part of Okinawa resulted the Yanbaru and Amami-Oshima as "Noah's ark".

ACNOWLEDGMENTS

We would like to express our sincere thanks with deep respect to Messrs. Seikou Ohyama, Seishin Ohyama, and Morimasa Ohyama, sons of the late Mr. Seiho Ohyama, and the late Mr. Chokei Kishaba of Naha City. Mr. Kishaba was a good friend and colleague of Mr. Seiho Ohyama and promoted the paleontology and paleoanthropology of Okinawa in his life.

Thanks are also go to Dr. Makoto Manabe of National Science Museum, Messrs. Koushou Kamiya and Kenji Takehara of Okinawa Prefectural Museum, and Doctors Storrs L. Olson and Helen F. James of National Museum of Natural History, Smithsonian Institution who helped to examine the collection housed in the museums. Mr. Yuichi Kitamura embodied our image of paleo-scenery of Minatogawa as a beautiful drawing. This paper was greatly improved by numerous significant comments and suggestions by reviewers Dr. Takeshi Yamasaki of Yamashina Institute of Ornithology and Mr.Hollis Willi Butts of Museum Import.

REFERENCES

Amami ornithologists' club (1997): Birds in Amami. Kagoshima, 288pp.

Baba, H. and Narasaki, S. (1991): Minatogawa Man, the Oldest Type of Modern *Homo sapiens* in East Asia. *The Quaternary Research*, 30 (2): 221-230.

Hasegawa, Y. (ed., 1978): The animal remain assemblage of Gohezu Cave. Research of the Gohezu Cave, Ie-son, Okinawa Prefecture - 2, Research report of the cultural resources of Ie-son, 5: 1-4, 8-17.

Hasegawa, Y. (1980): Vertebrates of the Late Pleistocene – Holocene Ryukyu Archipelago. *Quaternary Study*, 18(4): 163-167.

Hasegawa, Y. and Matsuoka, H. (2002): Chapter 3: The Minatogawa Fissure and the animals. *In* "Minatogawajin-ten" (a museum guide for special exhibition of Minatogawa Man, in Japanese), Okinawa Prefectural Museum. Naha, Okinawa: 26-34.

Hasegawa, Y., Chinzei, K., Nohara, T., Ikeya, N., Wada, H. and Oyama, S. (2017): Topography and deposits of late Pleistocene Minatogawa man site, Okinawa, Ryukyu Islands. *Bulletin of Gunma Museum of Natural History*, (21): 121-128.

Kaifu, Y. (2007). The cranium and mandible of Minatogawa 1 belong to the same individual: a response to recent claims to the contrary. *Anthropological Science*. 115 (2): 159-162.

Kawakami, K., Furuya, W., Kojima, T. and Nakayama, F. (2015) A record of Nankeen Night Heron *Nycticorax caledonicus* on Hahajima, Ogasawara Islands. *Jpn. J. Ornithol*., 64: 83–86.

Kawamura, Y. (1989): Quaternary rodent faunas in the Japanese Islands (Part 2). *Memoirs of the Faculty of Science*, *Kyoto University*, *Series of Geology and Mineralogy*, 54(1-2): 1-235.

Kodera, H. (2006): Inconsistency of the maxilla and mandible in the Minatogawa Man No. 1 hominid fossil evaluated from dental occlusion. *Anatomical Science International*, 81 (1): 57-61.

Kowalski, K. and Hasegawa, Y. (1976): Quaternary rodents from Japan. *Bulletin of National Science Museum*, *Tokyo* (*Geology Paleontology*), 2(1): 31-66, pl. 1.

Matsuoka, H. (2000): The Late Pleistocene fossil birds of the Central and Southern Ryukyu Islands, and their zoogeographical implications for the recent avifauna of the Archipelago. *Tropics*, 10 (1): 165-188.

Momiyama, T. (1930): On the birds of Bonin and Iwo-Islands. *Bulletin of the Biogeographical Society of Japan*, 1(3), 89-186.

Okinawa Prefectural Museum & Art Museum (2007): Great Journey of the Humankind. (A museum guide for special exhibition, in Japanese) Pp. 63. Okinawa.

Okinawa Yacho Kenkyu-kai (1993): Wild birds of Okinawa. Okinawa Shuppan, Okinawa, 300pp.

Olson, S. L. and James H. F. (1984): The role of Polynesians in the extinction of the avifauna of the Hawaiian Island. *In* Martin, P. and Klein, R. *eds*., Quaternary extinctions, University of Arizona Press: 768-780.

Olson, S. L. (1977): A synopsis of the fossil Rallidae. *In* Ripley, S. D. (ed.) Rails of the world: A monograph of the Family Rallidae. David R. Godine, Boston., p. 339-373.

Olson, S. L. (1973): Evolution of the rails of the South Atlantic islands (Aves: Rallidae). *Smithsonian Contributions to Zoology*, 152: 1-53.

Olson, S. L., 1990: The prehistoric impact of man on biogeographical patterns of insular birds. *Atti dei Convegni Lincei*, 85: 45-51.

Pratt, H. D., P. L. Bruner, and D. G., Berrett (1987): A Field Guide to the Birds of Hawaii and the Tropical Pacific. 409 pp., 45 pls. Princeton University Press, Princeton, New Jersey.

Steadman, D. W. (1995): Extinction of birds on tropical Pacific islands. *In* Steadman, D. W. and Mead, J. I. (eds.) Late Quaternary environments and Deep History: A tribute to Paul S. Martin, The Mammoth Site of Hot Springs, South Dakota: 33-49.

Suzuki, H. and Hanihara, K., eds. (1982): The Minatogawa Man: The Upper Pleistocene man from the island of Okinawa. *The University Museum*, *The University of Tokyo*, *Bulletin*, 19: 208 pp., 68 pls.

Suzuki, H. and Tanabe, G. (1982): Introduction. *In* Suzuki, H. and Hanihara, K., (eds.) The Minatogawa Man: The Upper Pleistocene man from the island of Okinawa. *The University Museum*, *The University of Tokyo*, *Bulletin*, 19: 1-5.

Takai, F. and Hasegawa, Y. (1971): On the vertebrate fossils of the islands of Ryukyu. *In* Geological problems of Kyushu sea area, Geological Sociery of Japan: 107-109.

Tsuchi, R. (1982): Geology of southern Okinawa Island, with reference to the formation of the Minatogawa Fissure. In Suzuki, H. and Hanihara, K. (eds.) The Minatogawa Man: The Upper Pleistocene Man from the Island of Okinawa. *The University Museum, the University of Tokyo*, *Bulletin*, 19: 197-204.

Takano, S. (1994): A Field Guide to the Birds of Japan. Wild Bird Society of Japan, Tokyo, 336pp.

Von den Driesch, A. (1976): A Guide to the Measurement of Animal Bones from Archaeological Sites. Peabody Museum Bulletin, (1). Peabody Museum of Archaeology and Ethnology, Harvard University, Cambridge, Massachusetts, U.S.A., 137pp.

Yamasaki, S. (2016): Palaeolithic Human Fossils of Okinawa and the Origin of Humans. (A museum guide for special exhibition, in Japanese). Okinawa, 58 pp.

Yamashina, Y. and Mano, T. (1981): A new species of rail from Okinawa Island. *Journal of Yamashina Institute for Ornithology*, 13 (3): 147-152, 3 pls.

「港川人」周囲の鳥類：沖縄島南部港川フィッシャーから産した後期更新世の鳥類化石群

松岡廣繁[1]・長谷川善和[2]

[1]京都大学大学院理学研究科地球惑星科学専攻地質学鉱物学教室：〒606-8502 京都市左京区北白川追分町
[2]群馬県立自然史博物館：〒370-2345 群馬県富岡市上黒岩1674-1

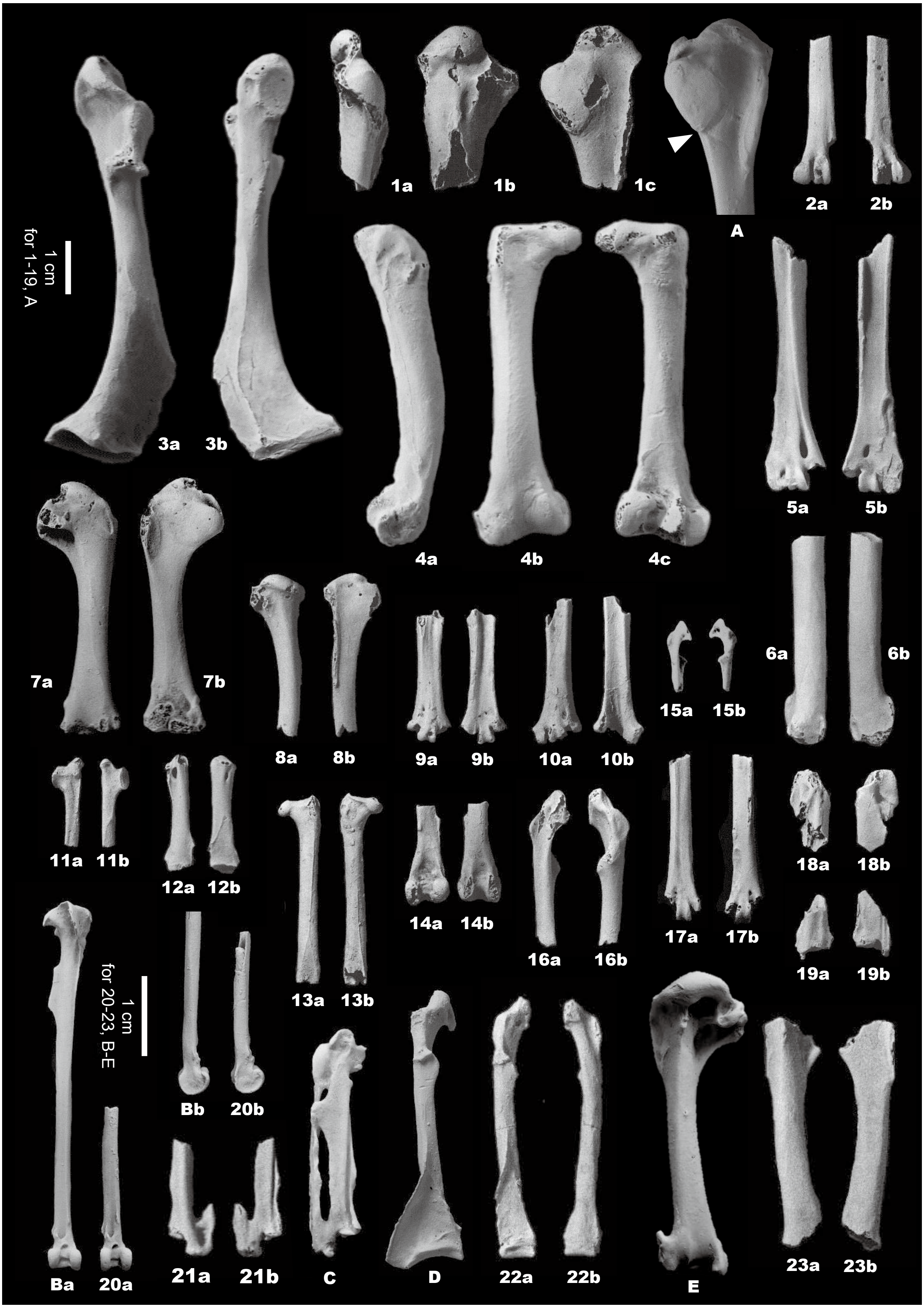
要旨：「港川人」として知られる後期更新世人の化石を産出したことで有名な沖縄島南部八重瀬町港川の港川フィッシャーは，また琉球列島の動物化石の産地としても極めて重要である．本研究ではこのうちの鳥類化石について，その特徴を報告する．1000点以上ある鳥類化石群から椎骨やあまりにも破片的で同定不能なものを除き，約820点についてほぼ種レベルの同定を完了して，8目10科に属する17 種・亜種を認めた．それらは，ズアカアオバト（ハト科）・ハト科の不明種・ウミウ（ウ科）・アカチャゴイ（標準和名はハシブトゴイであるが和名新称とした：サギ科）・サギ科の不明種・ヤンバルクイナ（クイナ科）・ヒクイナ（クイナ科）・ヤマシギ（シギ科）・オオヤマシギ（アマミヤマシギの新亜種：シギ科）・チュウヒ（タカ科）・サシバ（タカ科）・オオコノハズク（フクロウ科）・ルリカケス（カラス科）・リュウキュウハシブトガラス（カラス科）・ヒヨドリ（ヒヨドリ科）・オオトラツグミ（ヒタキ科 ）・シロハラ（ヒタキ科）である．オオヤマシギ*Scolopax mira ohyamai* ssp. nov.は現世アマミヤマシギ*Scolopax mira mira*に比して翼が大きく，飛翔能力が高かったと考えられる．港川の化石群のうち，オオヤマシギが化石点数の68%近くを占める．次に多産するヤンバルクイナと合わせて，95%に達する．港川古鳥類相の特徴は，総じて森林性の種が卓越し，港川人の生存時には周辺は現在のヤンバルのような森林であったと考えられる．鳥類化石の多くは，林床を歩き回っていた鳥がクレバス状の“自然の落とし穴”にはまって死亡し，堆積物に覆われたものと考えられる．港川古鳥類相はまた，ヤンバルクイナ（現在はヤンバルの固有種）やアマミヤマシギ・ルリカケス・オオトラツグミ（奄美大島周辺の固有種）という著しい固有種の化石が含まれる特徴がある．現在は島ごとに棲み分けているかのような固有鳥類であるが，後期更新世には中部琉球全体に均一的な鳥類相が広がっていたことが考えられる．ヤンバルや奄美の森林は，こうした固有鳥類の「ノアの箱舟」といえよう．

Explanation of Plate 1

1 to 23: The avian fossils from the Minatogawa Fissure.
A to E: The comparative osteological specimens of modern birds.
1. *Nycticorax caledonicus* (Pelecaniformes: Ardeidae). The proximal end of left humerus (Mb0135). a, ventral view; b, caudal view; c, cranial view. 2. An Ardeidae genus and species indeterminate. The distal end of left tarsometatarsus (Mb0271). a, anterior view; b, posterior view. 3, 4. *Phalacrocorax capillatus* (Suliformes: Phalacrocoracidae). 3. A nearly complete right coracoid (OMB15). a, dorsal view; b, ventral view. 4. A nearly complete right femur (OMB16). a, lateral view; b, anterior view; c, posterior view. 5. *Circus spilonotus* (Falconiformes: Accipitridae). The distal potion of left tarsometatarsus (Mb0145). a, anterior view; b, posterior view. 6. *Buteo buteo* (Falconiformes: Accipitridae). The distal portion of left ulna (Mb0146). a, dorsal view; b, ventral view. 7. *Treron formosae* (Columbiformes: Columbidae). A nearly complete right humerus (Mb0781). a, caudal view; b, cranial view. 8 to 14. *Otus lempiji* (Strigiformes: Strigidae). 8. The proximal portion of right humerus (Mb0134). a, caudal view; b, cranial view. 9. A right tarsometatarsus lacking the proximal portion (Mb0138). a, anterior view; b, posterior view. 10. A left tarsometatarsus lacking the proximal end (Mb0139). a, anterior view; b, posterior view. 11. A right scapula lacking the blade (Mb0113). a, ventral view; b, dorsal view. 12. A left coracoid lacking the top portion (OMB42). a, ventral view; b, dorsal view. 13. A left femur lacking the distal end (Mb0124). a, anterior view; b, posterior view. 14. The distal portion of left tibiotarsus (Mb0147). a, anterior view; b, posterior view. 15. *Hypsipetes amaurotis* (Passeriformes: Pycnonotidae). The cranial portion of right coracoid (Mb0784). a, ventral view; b, dorsal view. 16 to 19. *Corvus connectens* (Passeriformes: Corvidae). 16. The cranial portion of right coracoid (OMB45). a, ventral view; b, dorsal view. 17. The distal portion of right tarsometatarsus (OMB46). a, anterior view; b, posterior view. 18. A piece of proximal portion of left carpometacurpus (Mb0121). a, ventral view; b, dorsal view. 19. A piece of distal portion of left carpometacurpus (Mb0122). a, ventral view; b, dorsal view. 20. *Turdus pallidus* (Passeriformes: Muscicapidae). The distal portion of right tibiotarsus (OMB44). a, anterior view; b, lateral view. 21 to 23. *Zoothera major* (Passeriformes: Muscicapidae). 21. The distal portion of right carpometacarpus (Mb0126). a, ventral view; b, dorsal view. 22. An almost complete left coracoid (Mb0786). a, dorsal view; b, ventral view. 23. The shaft of left humerus (Mb0127). a, caudal view; b, cranial view.

A. The proximal portion of left humerus of *Nycticorax caledonicus caledonicus* (male), USNM-561542. The cranial view. See text for the explanation of arrowhead. B. A right tibiotarsus of recent *Turdus pallidus* from KUGM osteological collection. a, anterior view; b, lateral view. C. A right carpometacarpus of recent *Zoothera major* from KUGM osteological collection. The dorsal view. D. A left coracoid of recent *Zoothera major* from KUGM osteological collection. The dorsal view. E. A left humerus of recent *Zoothera major* from KUGM osteological collection. The caudal view.

Plate 1



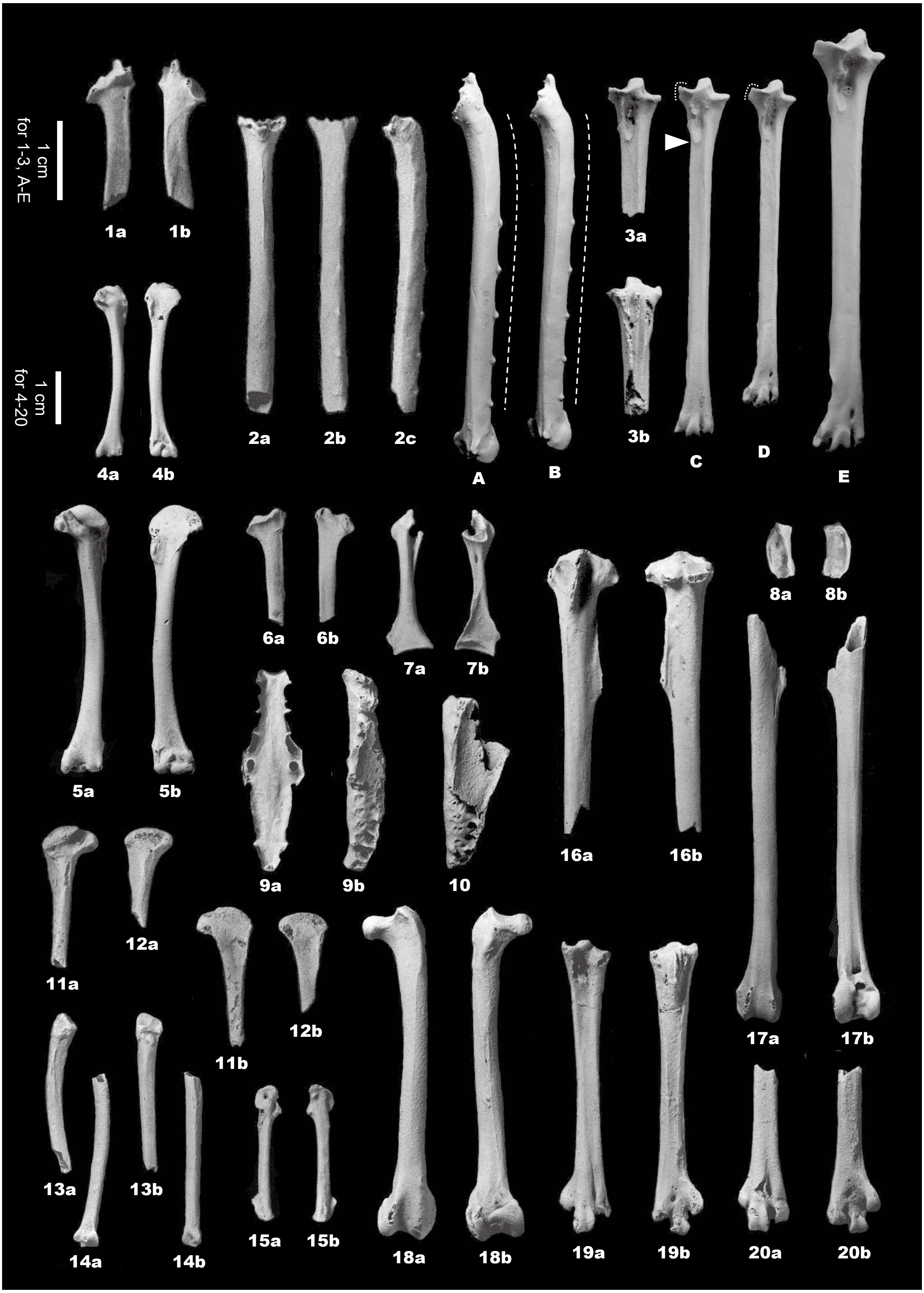
1 cm
for 1-19, A
1a
1b
1c
A
2a
2b
3a
3b
4a
4b
4c
5a
5b
6a
6b
7a
7b
8a
8b
9a
9b
10a
10b
15a
15b
11a
11b
12a
12b
13a
13b
14a
14b
16a
16b
17a
17b
18a
18b
19a
19b
1 cm
for 20-23, B-E
Ba
20a
Bb
20b
21a
21b
C
D
22a
22b
E
23a
23b

Explanation of Plate 2

1 to 20: The avian fossils from the Minatogawa Fissure.
A to E: The comparative osteological specimens of modern birds.
1 to 3. *Garrulus lidthi* (Passeriformes: Corvidae). 1. A right scapula lacking the distal blade (Mb0132). a, ventral view; b, dorsal view. 2. A left ulna lacks only the both ends (Mb0131). a, cranial view; b, caudal view; c, dorsal view. 3. The proximal portion of left tarsometatarsus (OMB43). a, anterior view; b, posterior view. 4. *Porzana fusca* (Gruiformes: Rallidae). A complete right humerus (Mb0253). a, cranial view; b, caudal view. 5 to 20. *Gallirallus okinawae* (Gruiformes: Rallidae). 5. A right humerus (Mb0160). a, cranial view; b, caudal view. 6. A right scapula lacking the distal blade (Mb0252). a, ventral view; b, dorsal view. 7. A right coracoid (Mb0065). a, ventral view; b, dorsal view. 8. A right phalanx proximalis digiti majoris (Mb0046). a, dorsal view; b, ventral view. 9. A synsacrum lacking the caudal end (Mb0227). a, ventral view; b, right lateral view. 10. An incomplete synsacrum with some portion of illium and median dorsal ridge (Mb0028). The right lateral view. 11. The proximal portion of left humerus of an immature individual (Mb0159). a, caudal view; b, cranial view. 12. The proximal portion of left humerus of a chick, more immature than Mb0159 (Mb0228). a, caudal view; b, cranial view. 13. A left ulna lacking the distal portion (Mb0216). a, ventral view.; b, cranial view. 14. A right ulna lacking the distal portion (Mb0169). a, ventral view.; b, cranial view. 15. A left carpometacarpus lacking the proc. extensorius and os metacarpale minus (Mb0043). a, ventral view.; b, dorsal view. 16. The proximal portion of left tibiotarsus (Mb0243). a, anterior view; b, posterior view. 17. A right tibiotarsus lacking the proximal portion (Mb0168). a, posterior view; b, anterior view. 18. A left femur (Mb0241). a, anterior view; b, posterior view. 19. A left tarsometatarsus (Mb0244). a, anterior view; b, posterior view. 20. The distal portion of left tarsometatarsus (Mbo224). a, anterior view; b, posterior view.

A. A left ulna of recent *Garrulus lidthi* from KUGM osteological collection. The dorsal view. See text for the explanation of broken line. B. A left ulna of recent *Garrulus glandarius* from KUGM osteological collection. The dorsal view. See text for the explanation of broken line. C. A left tarsometatarsus of recent *Garrulus lidthi* from KUGM osteological collection. The anterior view. See text for the explanation of dot line and arrowhead. D. A left tarsometatarsus of recent *Garrulus glandarius* from KUGM osteological collection. The anterior view. See text for the explanation of dot line. E. A left tarsometatarsus of recent *Corvus connectens osai* (*C. macrorhynchos osai*) from KUGM osteological collection. The anterior view.

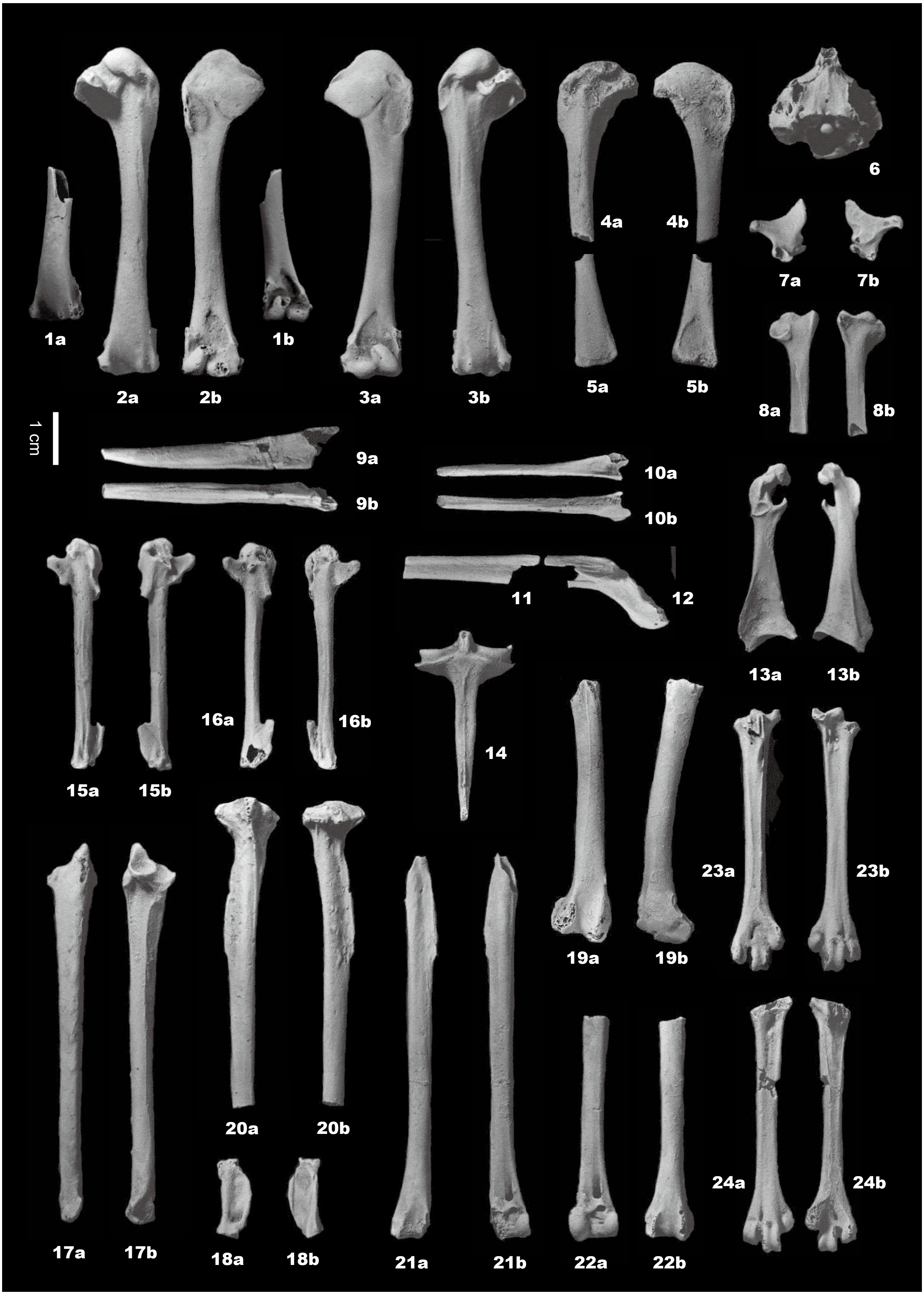
Plate 2


1 cm
for 1-3, A-E
1 cm
for 4-20
1a
1b
2a
2b
2c
A
B
3a
3b
C
D
E
4a
4b
5a
5b
6a
6b
7a
7b
8a
8b
9a
9b
10
11a
11b
12a
12b
13a
13b
14a
14b
15a
15b
16a
16b
17a
17b
18a
18b
19a
19b
20a
20b

Explanation of Plate 3

1 to 24: The avian fossils from the Minatogawa Fissure.
1. *Scolopax rusticola* (Charadriiformes: Scolopacidae). The distal portion of right humerus (OMB41). a, caudal view; b, cranial view. 2 to 24. *S. mira ohyamai* ssp. nov. (Charadriiformes: Scolopacidae). 2. The holotype right humerus (Mb0286). a, caudal view; b, cranial view. 3. A left humerus (Mb0288). a, cranial view; b, caudal view. 4. The proximal portion of left humerus of an immature individual (Mb0089). a, caudal view; b, cranial view. 5. The distal portion of left humerus of an immature individual (Mb0504). a, caudal view; b, cranial view. 6. A fragmentary cranium (Mb0581). The ventral view. 7. A right quadrate (Mb0300). a, lateral view; b, medial view. 8. A left scapula lacking the distal blade (Mb0740). a, dorsal view; b, ventral view. 9. The paratype rostrum piece, the basic part of naso-premaxillary (Mb0644). a, lateral view; b, dorsal view. 10. The dorsal portion of right premaxilla (Mb0457). a, ventral view; b, dorsal view. 11. The middle portion of left mandible (Mb0716a: broken to a and b). The lateral view. 12. The articular portion of left mandible (Mb0716b). The lateral view. 13. A left coracoid (Mb0611). a, dorsal view; b, ventral view. 14. A fragmentary sternum (Mb0307). The cranial view. 15. The paratype left carpometacarpus lacking os metacarpale minus (Mb0399). a, dorsal view; b, ventral view. 16. A right carpometacarpus lacking os metacarpale minus (Mb0332). a, ventral view; b, dorsal view. 17. The paratype left ulna (Mb0312). a, caudal view; b, cranial view. 18. A right phalanx proximalis digiti majoris (Mb0757). a, dorsal view; b, ventral view. 19. A left femur lacking the proximal end (Mb0557). a, anterior view; b, lateral view. 20. A right tibiotarsus lacking the distal portion (Mb0395). a, anterior view; b, posterior view. 21. A right tibiotarsus lacking the proximal portion (Mb0394). a, anterior view; b, posterior view. 22. The distal half of right tibiotarsus (Mb0558). a, anterior view; b, posterior view. 23. A left tarsometatarsus (Mb0615). a, posterior view; b, anterior view. 24. A right tarsometatarsus (Mb0630). a, anterior view; b, posterior view.

Plate 3


1a
1b
2a
2b
3a
3b
4a
4b
5a
5b
6
7a
7b
8a
8b
1 cm
9a
9b
10a
10b
11
12
13a
13b
14
15a
15b
16a
16b
17a
17b
18a
18b
19a
19b
20a
20b
21a
21b
22a
22b
23a
23b
24a
24b