

Were they wild? : traditional bone observations and ancient DNA and stable isotope analyses for goose (Anserinae) archaeological remains from Japan

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Introduction

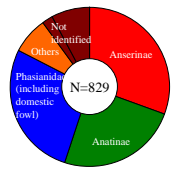
According to the historical literatures, domestic geese that would be domestic *Anser cygnoides* have been bred in Japan since AD 9th century and were sold at markets up to AD 17th century. In contrast, few goose (Anserinae) bones from archaeological sites in Japan have been identified as domesticated. The discrepancy between zooarchaeological and historical studies is likely caused by the difficulty in distinguishing domesticated goose bones from wild ones. On the other hand, Barnes et al (2000) suggested that ancient DNA analysis is useful to identify domestic goose bones in England, whereas biometric differences between wild and domestic geese are ambiguous.

The purpose of this study is:

- 1) applying different methods to a plausible relationship between biological features of geese and human activities, and,
- 2) examining goose remains by these methods.

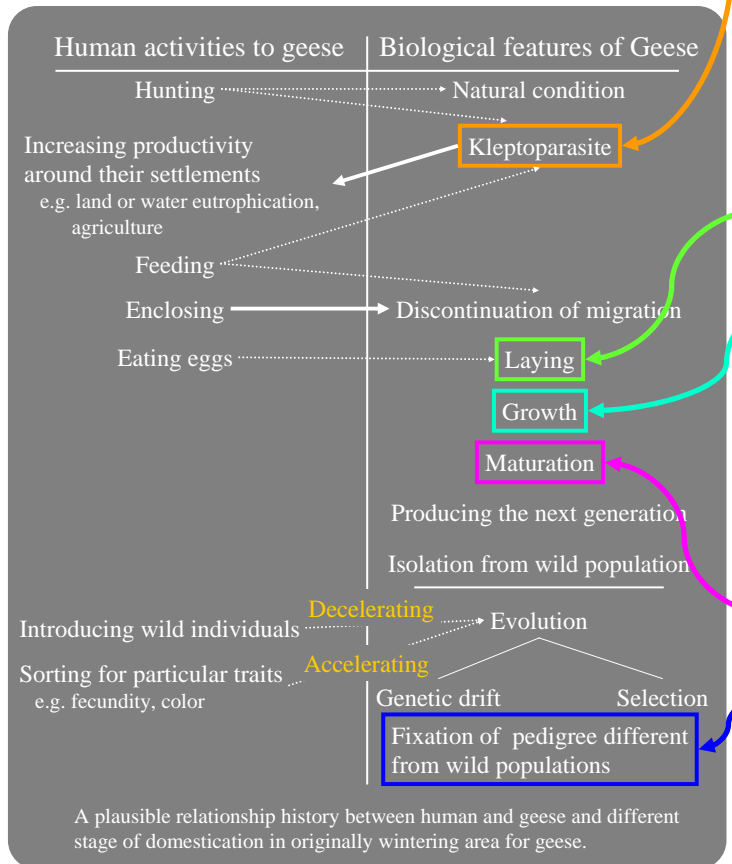
Materials

Goose bones (265 samples) from the Shiodome site, which was a feudal lord's property in Tokyo, and occupied from the AD 16th to 19th century.



Bird remains from the Shiodome site. Others included Diomedelidae, Gruidae, Ciconiidae, and so on.

Different methods applied to each issue

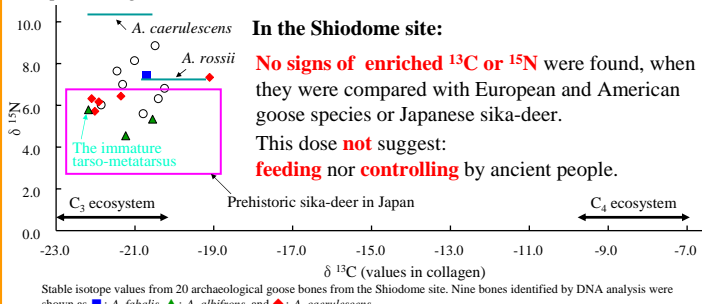


Stable isotope analysis

Assumptions:

Wild geese breed in polar regions and winter in temperate regions, while domesticated ones stayed in Japan and might be fed agricultural plants. Agricultural plants might be more nutrient than wild plants and include C_4 plants that have enriched ^{13}C than C_3 plants.

Therefore, carbon and nitrogen stable isotope ratios in domesticated geese expected higher than ones in wild.



In the Shiodome site:
No signs of enriched ^{13}C or ^{15}N were found, when they were compared with European and American goose species or Japanese sika-deer. This does **not** suggest: **feeding nor controlling** by ancient people.

Observation of medullary bone

Assumptions:

Wild geese don't breed in Japan. In general, only laying females have medullary bones. **Therefore,** bones including medullary bones suggest: they bred in Japan and might be domesticated.

In the Shiodome site:

No medullary bones were found, although 32 geese tibio-tarsi and femora were observed by eye or X-ray. This suggests: **no breeding female** was included.



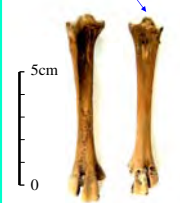
Further studies are required for: human consuming strategy for breeding birds and examination by X-ray



An example of examination by X-ray. The left two bones are reference that included medullary bones.

Observation of condition of agglutination

Identified to *A. albifrons* by DNA analysis



Assumptions:

Wild geese don't breed in Japan. In general, bird bones are fully fused before migration. **Therefore,** bones showing insufficient fusing suggest: they were born in Japan and might be domesticated.

In the Shiodome site:

Only one of 265 observed bones showed insufficient fusing, although not "stereotypic" nestlings. This suggests: the specimen is **just after migrated or domesticated**. Further studies are required for bones of nestlings.

Biometric analysis (The results is in my pocket, please ask me!)

Ancient DNA analysis

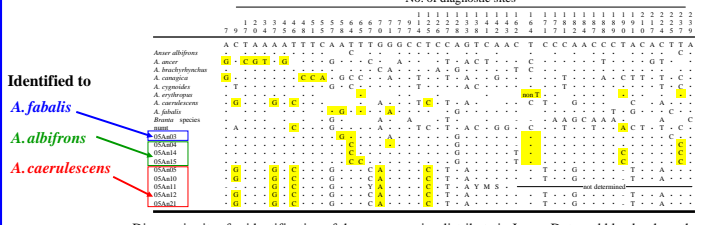
Assumptions:

Genetic markers are useful to identify monophyletic individuals. In general, a species are monophyletic to the other species. It is unknown whether domestic geese were monophyletic in the past. Biometric differences among goose species are ambiguous.

Therefore, DNA analysis were used to identify species in this study, since further studies on phylogeographic structure and obviously domestic geese for each species are required for differentiation of domestic individuals from wild ones.

In the Shiodome site:

Nine of 20 (45%) bones were succeeded in analysis. They were identified to *A. caerulescens* (5 samples), *A. albifrons* (3 samples) and *A. fabalis* (1 sample), whereas *A. cygnoides* that was the dominant domestic goose species in Japan was not found.



Diagnostic sites for identification of the geese species distribute in Japan. Dots and blanks show the identical nucleotide to the reference sequence (top) and not fixed within the species, respectively. Two primer pairs, one from Barnes et al (2000) and another from newly designed, in the mtDNA control region domain I were used to amplify the target sequence (ca. 234bp). Since multiple substitutions were observed in the sequences, species identification was conducted by parsimonious fashion focusing on some diagnostic sites, referring to the sequences in GenBank.

Discussion

Why there was no sign of domesticated geese in the Shiodome site?

- 1) too small sample size
→usage of domesticated geese was uncommon?
- 2) bias in analyzed samples
→usage of domesticated geese was uncommon for Feudal lords?

The different methods used in this study can reveal the different biological features of geese.

→combining these methods will be useful to reveal the process of domestication.

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