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Pleistocene Ranid Frog from a Lake Deposit in Kyushu, Japan

By

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Abstract Three Pleistocene fossil frogs from Kusu, Oita Prefecture are the first record in Kyushu island. These specimens are identified as *Rana ornativentris*, a modern species still present on the island as well as on Shikoku and Honshu islands.

Introduction

During a geological survey of the Kusu district in October, 1983, the junior author discovered a frog fossil in a cliff of the Ryumon Member within the Kusu Formation in Kokonoe-machi, Kusu-gun, Oita Prefecture. He continued to survey the same cliff, and the second and third specimens were found in 1985.

This is the first record of fossil frogs from Kyushu. Fossil frogs found in the lacustrine sediments are rather rare in Japan.

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Geological Setting

The fossil locality is a cliff east of Ryumon Falls, Kokonoe-machi, Kusu-gun, Oita Prefecture (Fig. 1) currently owned by Yoshitomi Industry Co. Ltd. A geologic columnar section at this locality is provided at Fig. 2.

IWAO (1981) and IWAO & Matsuo (1982) studied the fossil plants and geology of the Kusu District. In these studies, the Kusu Formation was divided in ascending order into the Takize, Hosenji, Nogami, and Ryumon Members.

There are many reports concerning the age of the Hohi volcanic rocks, including 0.7 ± 0.4 Ma, 0.9 ± 0.4 Ma (KAMATA & MURAOKA, 1982) and 0.8–2.0 Ma (UTO & SUTO, 1985) using the K-Ar method and 1.8–2.1 Ma (TAMANYU, 1980) with the fission track method. The rhyolites from this locality are considered as a part of the Haneyama

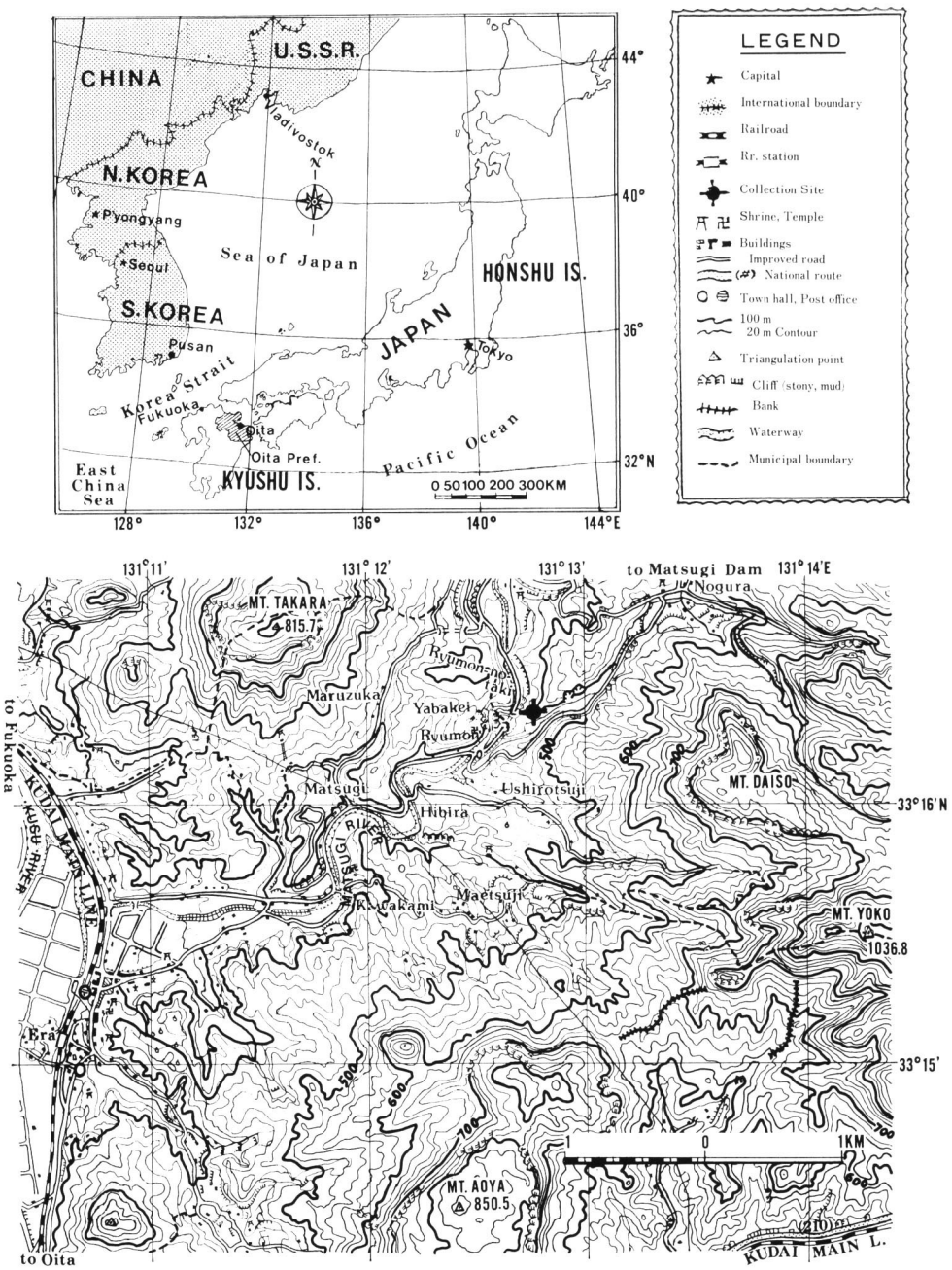

Fig. 1. A topographic map of Kusu area. The position of the outcrop is indicated by a black circle with cross.

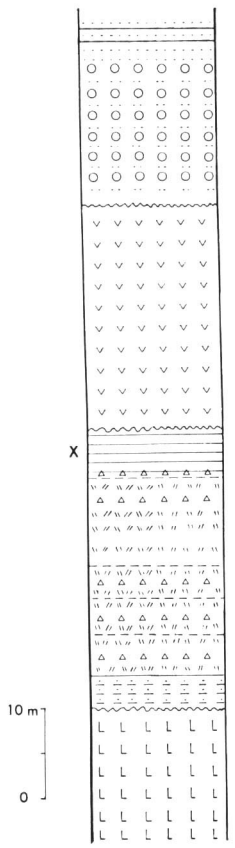

Fig. 2. Columnar section of fossil locality.

1. Lower Member of New Hohi volcanics; two-pyroxene andestic and auto-brecciated lavas.
2. Nogami Member; alternating beds of sandstone and mudstone.
3. Ryumon Member; tuff breccia to tuff beds (containing thin mud and sandstone beds).
4. Ryumon Member; mudstone (containing andesite breccia).
5. Ryumon Member; diatomaceous mudstone.
6. Yabakei welded tuff; rich in hornblende, feldspar, and accidental xenolith.
7. Channel filled sediment; conglomerates to sandstone beds.
8. Channel filled sediment; sandstone and mudstone bed.

X. Horizon of the frog fossils.

lavas, and dated at 1.17±0.13 Ma (UTO & SUTO, 1985) and 1.3±0.3 Ma (SUTO, 1985 b) with the K-Ar method.

With the fission track method, the Yabakei welded tuff has an age of 0.40 Ma (MATSUMOTO *et al.*, 1977) and 0.38±0.13 Ma (TAMANYU, 1981), while with the K-Ar method, it is dated as 1.7±0.7 Ma, 1.4±0.2 Ma, 1.3±0.2 Ma (SUTO, 1985 a), and 0.99±0.03 Ma (UTO & SUTO, 1985).

Although the geological age of the Ryumon Member is yet to be accurately determined (fission track dating and K-Ar methods do not agree with each other in this area, SUTO, 1985a, b), it may be considered Pleistocene.

Systematic Paleontology

Order Salientia LAURENTI, 1768
Family Ranidae GRAY. 1825
Genus *Rana* LINNAEUS, 1758

Osteological characters: Width of fronto-parietal narrow compared to its width; length of parasphenoid equal to its width of alae; teeth present on maxilla; anterior margin of clavicular process of scapula concave; diapophysis of sacrum rod-like; ilial crest of ilium present; no deltoid crest of femur present (NOKARIYA, 1984).

Rana ornativentris WERNER, 1904

(Figs. 3–10)

Locality and horizon: Kokonoe-machi, Kusu-gun, Oita Pref., Kyushu, Japan.

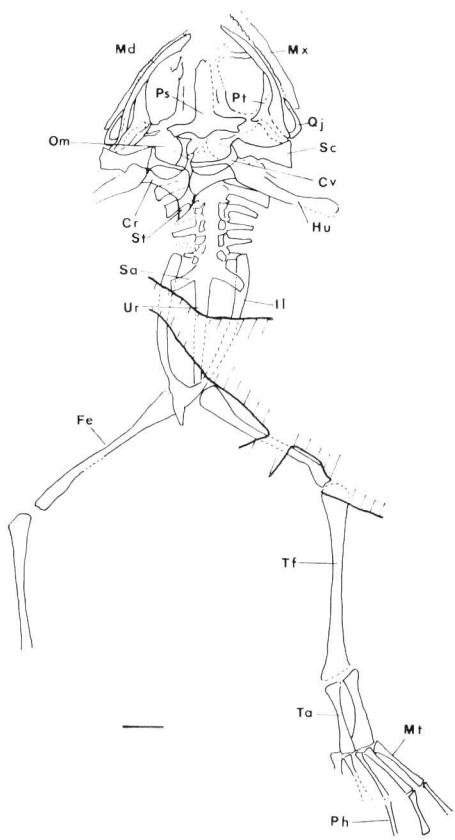

Fig. 3. Dorsal view of *Rana ornativentris* fossil. (NSM PV-18692a) A scale indicates 5mm.

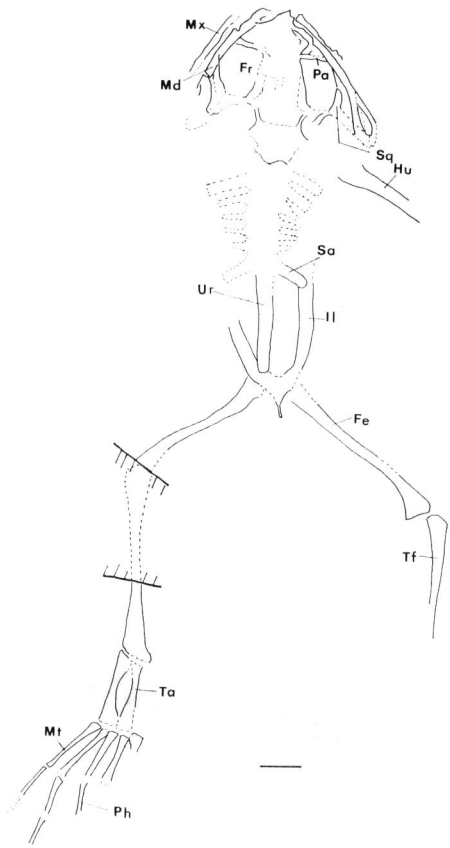

Fig. 4. The Counter part of Fig. 3. A scale indicates 5 mm.

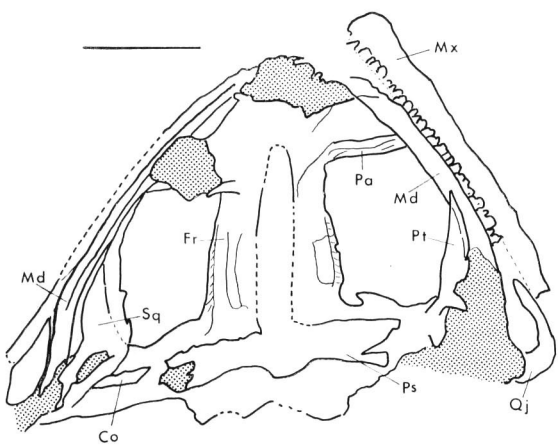

Fig. 5. Enlargement of skull. (Fig. 3) region. A scale indicates 5 mm.

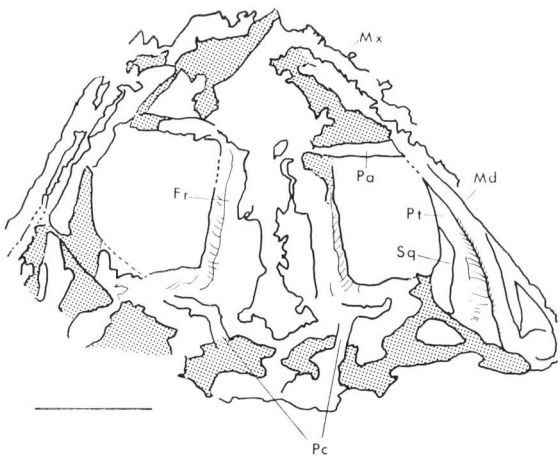

Fig. 6. Enlargement of skull. (Fig. 4) region. A scale indicates 5 mm.

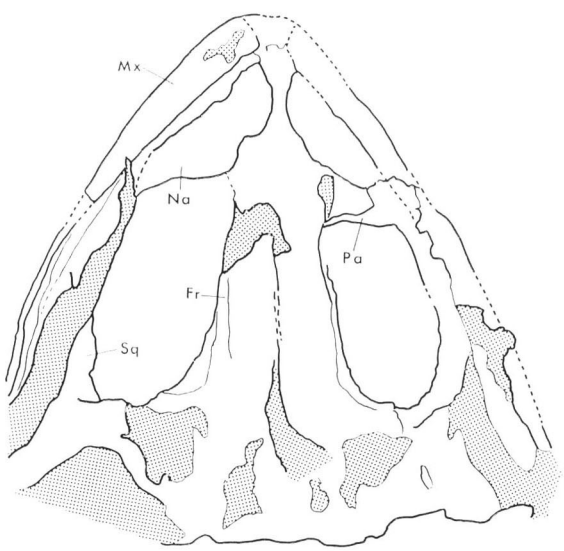

Fig. 7. Dorsal view of *Rana ornativentris* (KC-851024). A scale indicates 5 mm. Co: Columella, Cr: Coracoid, Cv: Clavicle, Fe: Femur, Fr: Fronto-parietal, Hu: Humerus, Il: Ilium, Md: Mandible, Mt 2–5: Metatarsus 2–5, Mx: Maxilla, Na: Nasal, Om: Omosternum, Pa: Palatine, Pc: Parietal crest, Ph: Phalanges, Ps: Parasphenoid, Pt: Pterygoid, Qj:Quadrate-jugal, Sa: Sacrum, Sc: Scapula, Sq: Squamosal, St: Sternum proper, Ta: Tarsus, Tf: Tibio-fibula, Ur: Urostyle, Ve: Vertebrae.

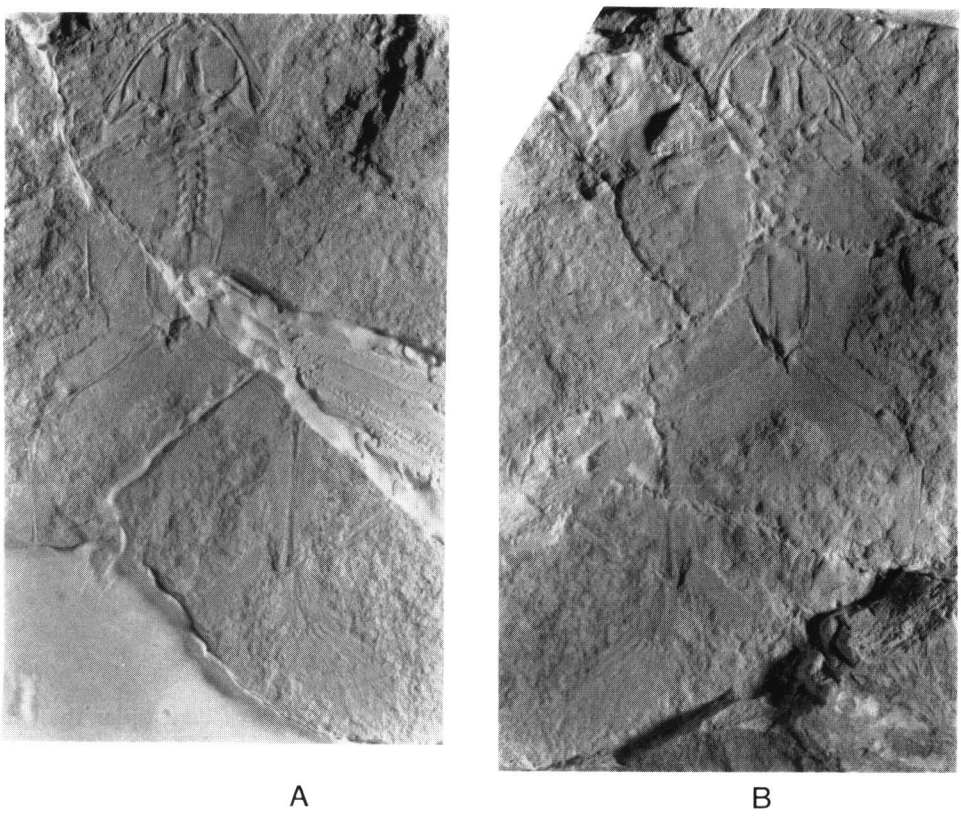

Fig. 8. *Rana ornativentris* fossil (NSM PV-18692a). A—see Fig. 3; B—see Fig. 4. A scale indicates 10mm.

Ryumon Member of Kusu Formation; Pleistocene.

Material: Three specimens examined; NSM PV-18692 a, b (Figs. 3–6, 8 A, B), KC-850929 (KITABAYASHI collection) (Figs. 9 A, B), KC-851024 (Figs. 7, 10).

Description

Cranium: Almost all bones preserved in their original positions (Fig. 7).

Fronto-parietal: Body decreases in its width toward its proximal end; both ends not clear (Figs. 3–7).

Prooticum: proximal ends of parietal crest project anteriorly (Fig. 7); parietal crest developed (Fig. 6) as in Recent forms of *Rana*.

Nasal: body wide (Fig. 7).

Maxilla: height of body almost equal; teeth poorly preserved and their crown missing (Figs. 5, 6); distal end of body disarticulated from quadrato-jugal (Figs. 5, 7).

Palatine: body rod-like (Figs. 5, 6); distal end of body wide (Fig. 7).

Squamosal: anterior arm developed and projects forward; middle and posterior

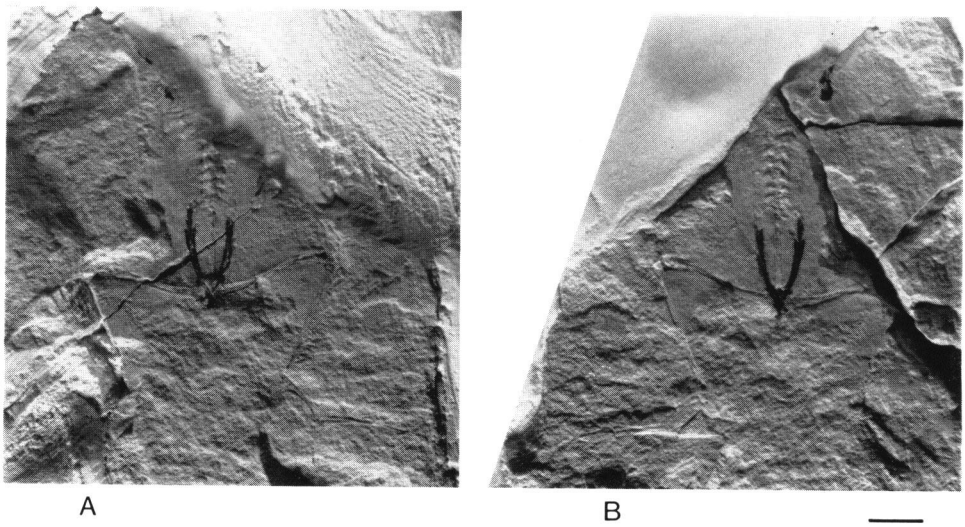

Fig. 9. *Rana ornativentris*. fossil (KC-850929). A—Dorsal view; B—Counter part. A scale indicates 10 mm.

arms not clear.

Pterygoid: anterior arm well-developed.

Parasphenoid: alae well developed and wide; distal end of alae wider than its base; length of body longer than that of alae; distal end of body equal to level of both distal ends of alae; angle between proximal margin of alae and body almost at 90°; proximal end of body same level of both palatines.

Columella: left side preserved (Fig. 5); width of proximal end wider than that of distal one.

Omosternum: proximal end of body not pointed.

Scapula: anterior margin of clavicular process concave.

Clavicle: body slender; distal end expanded.

Coracoid: proximal end wider than distal; anterior margin strongly curved.

Sternum proper: body wide at proximal end.

Humerus: rod like shaped.

Vertebrae: eight vertebrae preserved (Fig. 3); transverse process of third vertebra preserved and project latero-posteriorly (Fig. 9 B); those of third and fourth vertebrae broad and strong; those of fourth and fifth vertebrae project latero-posteriorly; those of sixth, seventh, and eighth vertebrae project almost laterally; sacral diapophysis of sacrum project latero-posteriorly.

Pelvic girdle: ilium and ischium preserved; ilial crest present on left ilial process of ilium (Figs. 9 A, B).

Femur: S-shaped body; both ends wide; deltoid crest not preserved; length of tibio-fibula longer than that of femur.

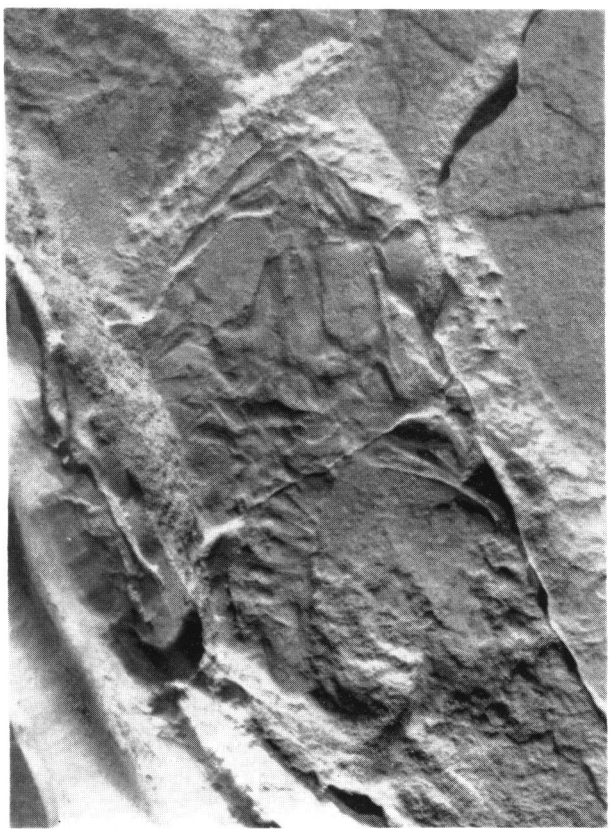

Fig. 10. *Rana ornativentris* fossil (KC-851024). see Fig. 7. A scale indicates 10 mm.

Tibio-fibula: proximal and distal parts of left body missing (Figs. 9 A, B); distal end of body wide (Figs. 3, 4).

Tarsus: both tibiale and fibulale slender, distal end of body wide.

Pes: rod like bones.

Comparisons

Fossils of *Rana* has been found in more than ten localities in Japan; however, only two cases are known from lake deposits: *Rana architemporaria* OKADA, 1937 from the Kabutoiwa area, Upper Miocene in Nagano Prefecture, and *Rana siobarensis* SHIKAMA, 1955 from Shiobara, Lower Pleistocene, Tochigi Prefecture. Two ranid fossil frogs have been discovered in lake deposits in China: *Rana basaltica* YOUNG, 1936 from Shantung, Miocene and *Rana yueshensis* LIU, 1961 from Wusiang, Lower Pliocene, Shansi.

Table 1. Measurements.

	NSM PV-18692		KC-850929				KC-851024	
	A	B	A		B			
Length of skull	17.0+						19.6+	
Width of skull	26.2						22.7+	
Length of fronto-parietal	8.6+						L. 2.7	R. 2.9
Width of fronto-parietal	6.1							
Length of parasphenoid	10.2							
Width of parasphenoid across alae	10.3							
Length of nasal							L. 7.0	
Width of nasal							L. 2.8	
Length of maxilla	R. 17.5+	L. 17.3+						
Length of pterygoid	R. 9.5	L. 9.6						
Length of squamosal	L. 6.0	L. 7.6						
Length of orbit	R. 7.2	L. 6.9					L. 7.8	
Width of orbit	R. 5.5	L. 4.6					L. 4.3	R. 3.8
Length of mandible	L. 17.0+	L. 15.6+						
Length of omosternum	2.6							
Length of scapula	R. 7.5	L. 6.2						
Length of clavicle	R. 4.9	L. 4.2						
Length of coracoid	R. 5.7	L. 5.2						
Length of sternum proper	3.0+							
Length of vertebrae	16.8		15.0+		17.2			
Length of urostyle		12.2+	12.7		13.1			
Length of pelvis	21.4		L. 18.5	R. 18.2	L. 20.0	R. 19.2		
Length of femur	L. 20.9	L. 22.5	L. 21.1	R. 20.2+	L. 21.4			
Length of tibio-fibula	R. 24.4	R. 17.2+	L. 23.8		L. 23.6			
Length of tarsus	R. 10.4		L. 7.9		L. 8.1			
Total length of body	51.4+							

(mm)

The present specimens represent the first discovery of fossil frogs in Kyushu. One of these, (Figs. 3, 4) NSM PV-18692 a, b, is comparatively well preserved. The total body length of this specimen is 51.4+ mm, and is the largest fossil *Rana* ever found in Japan and China. The Kyushu specimens exhibit femurs shorter than the tibio-fibula. *Rana brevipoda* and *R. nigromaculata* differ in that theyhave femurs longer than or almost equal to the tibio-fibula. *Rana architemporaria* has femurs almost equal to the tibiofibula in length.

The parietal crest is well developed in the present specimens, and the anterior projection of the parietal crest is present (Figs. 6, 7). This projection is present in Recent species of *Rana*, but is absent in other fossil species, such as *R. architemporaria*, *R. siobarensis*, and *R. basaltica*.

The cranium is not well preserved, so the only meaningful comparison was made for the parasphenoid. The parasphenoid of the present fossil specimen (Fig. 5) NSM PV-18692a, is similar to that of *Rana rugosa* and *R. ornativentris*. Although the proximal end of the parasphenoid is missing, its impression is preserved, making it evident that the parasphenoid reaches to both palatine bones. Based on this evidence, *Rana rugosa* is omitted from consideration. The parasphenoid is also missing in *Rana architemporaria*, *R. siobarensis*, and *R. basaltica*.

On the basis of the above comparisons, the authors consider that the fossil specimens described above belong to Recent *Rana*, and among the six species of the genus *Rana* that are distributed throughout Honshu and Kyushu (NAKAMURA and UÉNO, 1963), they can be considered identical to *Rana ornativentris*.

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