

Spirinchus akagii, a New Miocene Smelt from Tottori Prefecture,
Japan (Pisces: Osmeriformes: Osmeridae)

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Abstract Specimens of a fish found in the Middle Miocene Iwami Formation, Tottori Group, Tottori Prefecture, Japan, are described as a new species of the smelt family Osmeridae of the order Osmeriformes, *Spirinchus akagii*. The new species is characterized by greatly enlarged and thickened rays and proximal pterygiophores of the anal fin in presumed males and about 48–50 vertebrae.

Key words: Miocene, Iwami Formation, smelt, Osmeriformes, Osmeridae, *Spirinchus akagii* sp. nov.

Introduction

The Middle Miocene Iwami Formation of the Tottori Group at Miyanoshita, Kokufu-cho, Tottori Prefecture, has yielded many fishes, and is regarded as one of the best representative localities of a shallow marine ichthyofauna in the Miocene of Japan and western Pacific region (Uyeno & Sakamoto, 1997; Uyeno *et al.*, 1999). As the fifth account in a series describing the fishes from this fossil locality, we report a new osmerid fish of the order Osmeriformes, being distinct in the anal fin structure of presumed males and the number of vertebrae.

Systematic Paleontology

Class Osteichthyes Huxley, 1880

Order Osmeriformes Weitzman, 1967

Family Osmeridae Regan, 1913

Genus *Spirinchus* Jordan and Evermann, 1896

Spirinchus akagii sp. nov.

(New Japanese name: Miyanoshita-shishamo)

Figs. 1–3

Holotype: Tottori Prefectural Museum catalogue number TRPM 664-062, about 60 mm in estimated total length (TL), presumed male.

Paratype: TRPM 664-074, about 45 mm TL, presumed female.

Non-type specimens: TRPM 664-017, presumed male; TRPM 664-070, presumed female; National Science Museum catalogue number NSM PV-18338, presumed female; NSM PV-18339, presumed male; NSM PV-18340, presumed female; NSM PV-18341, presumed female; NSM PV-18342, sex not presumed; Mr. Toshiteru Maruo collection No. 13 (now deposited in the Fukui Prefectural Museum), presumed male.

Horizon: All specimens were discovered from the rock belonging to the Middle Miocene Iwami Formation of the Tottori Group at Miyanoshita, Kokufu-cho, Tottori Prefecture, Japan. The locality is reviewed in detail by Uyeno *et al.* (1999).

Etymology: Named after Dr. Saburo Akagi, former professor of Tottori University, for his contribution to the geology of the Tottori Prefecture.

Diagnosis: A small species of *Spirinchus* with greatly enlarged and thickened anal fin rays and proximal pterygiophores in males and about 48–50 vertebrae.

Description of the holotype (presumed male): The specimen is well-preserved, although the head and anterior portion of the body are lacking (Figs. 1; 3-1, 2). The body appears slender.

The dorsal fin originates behind the insertion of the pelvic fin, comprising 13 soft rays. There are 13 proximal pterygiophores. The origin of the anal fin is posterior to the end of the dorsal fin. Sixteen soft rays and 15 proximal pterygiophores are greatly enlarged and thickened, anterior proximal pterygiophores being most stout in particular. The first proximal pterygiophore is the most enlarged and is directed anteriorly with an angle of about 30° to the vertebrae. The second lies parallel to the first. The third is directed with an angle of about 60° to the vertebrae. The fourth to the last are parallel to each other and directed at approximately 90° to the vertebrae. The ratio of the length of the proximal pterygiophore to its associated haemal spine at the middle part of the anal fin is about 2 : 1. The insertion of the pelvic fin is in advance of the origin of the dorsal fin. There are 8 soft rays. The caudal fin is forked and composed of about 21 principal rays with about 5 procurrent rays in both the upper and lower extremes.

In the caudal skeleton, one parhypural, six hypurals, two epurals and an uroneural are observable. Fortyfour vertebrae remain and the total number is estimated as approximately 48–50. The number of abdominal vertebrae with neural spines are estimated as 21–23. Ribs are attached to the abdominal vertebrae. There are 27 caudal vertebrae with neural spines and haemal spines.

No supraneurals are visible. Epimerals are observed around the bases of the anterior five neural spines in the specimen. Epipleurals are visible on the ribs of the seventh and eighth abdominal vertebrae at least. Epicentrals are not visible.

An adipose fin is not present. Scales are cycloid.

Description of the paratype (presumed female): The specimen is well-preserved (Fig. 2). The body is slender. The head region is preserved, but each skeletal element

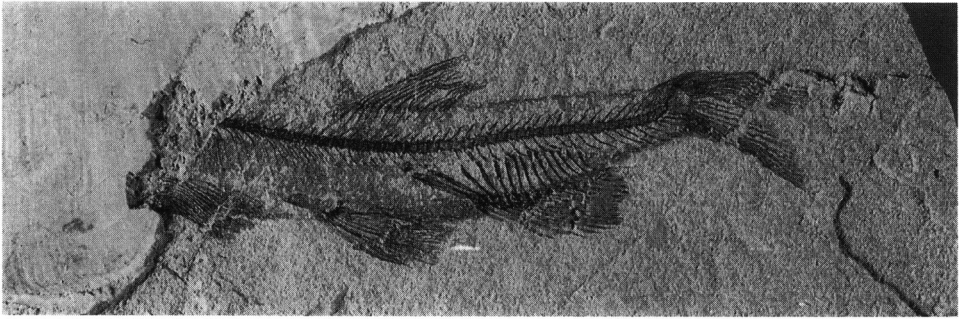


Fig. 1. The holotype of *Spirinchus akagii* sp. nov., TRPM 664-062, presumed male, from the Middle Miocene Iwami Formation, Tottori Prefecture, Japan. About 60 mm in estimated total length.

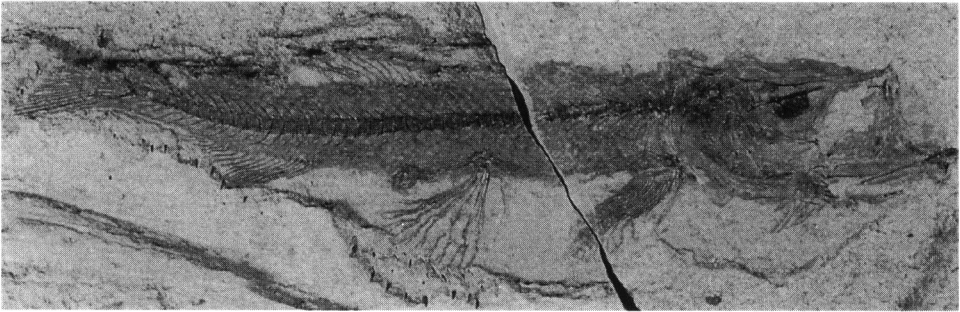


Fig. 2. The paratype of *Spirinchus akagii* sp. nov., TRPM 664-017, presumed female, from the same locality as the holotype. About 45 mm in total length.

is difficult to identify, except for the following bones:

In the jaws, the premaxilla, maxilla, dentary and articular remain. Anterior two teeth are visible on the dentary. Eight branchiostegals are visible on the ventral side of the hyoid arch.

The pectoral fin is low and located near the ventral margin of the body. There are 17 soft rays. The relative position and structure in the dorsal, anal and pelvic fins are very similar to the holotype, except for the structure of the anal fin. The dorsal fin comprises about 12 soft rays and 11 proximal pterygiophores. The anal fin comprises 17 soft rays. About 10 proximal pterygiophores remain and the total number is estimated as 16. The anal fin rays and their proximal pterygiophores are not enlarged and slender in comparison with those in the holotype, but the mode of the arrangement of the proximal pterygiophores is similar to the holotype. The proximal pterygiophores are subequal in length to their associated haemal spines at the middle part of the fin. The pelvic fin is composed of eight soft rays. The caudal fin is forked. The upper lobe of the fin and upper portion of the skeleton are lacking, and 13 principal rays with

five procurent rays, a parhypural and two hypurals are present.

There are 49 vertebrae composed of 24 abdominal and 25 caudal vertebrae. The structure in the abdominal and caudal vertebrae including ribs is similar to that in the holotype.

No supraneurals are observed. Epimerals are observable around the base of the first to eighth neural spines. Epicentrals and epipleurals are not present.

An adipose fin is not visible. Scales are cycloid.

Remarks on the non-type specimens: In a presumed male specimen (Mr. Toshiteru Maruo collection No. 13), the enlarged and thickened proximal pterygiophores of the anal fin are spatulate (Fig. 3-3).

Sexual dimorphism: In the presumed male specimens, the anal fin has greatly enlarged and thickened rays and proximal pterygiophores. In the presumed females, the anal fin rays and their proximal pterygiophores are more slender, as in an extant species of the genus, *Spirinchus lanceolatus*.

Discussion

The present species is characterized by having greatly enlarged and thickened anal fin rays and proximal pterygiophores in presumed male specimens. According to McAllister (1963) and Wilson and Williams (1991), the sexually dimorphic anal fin, similar to that of the present species, is found only in osmeriform fishes of the Salangidae and several genera of the Osmeridae. The present species is apparently included in the Osmeridae rather than the Salangidae in its general appearance.

In the family Osmeridae, distributed in the Northern Hemisphere, 18 species and subspecies in 9 genera including a Paleocene and two Oligocene species have been reported (McAllister, 1963; Gaudant & Burkhardt, 1984; Wilson & Williams, 1991; Saruwatari *et al.*, 1997).

The anal fin rays and proximal pterygiophores, enlarged and thickened to some extent, are found in males of all or some species in each genus such as *Osmerus*, *Thaleichthys*, *Spirinchus* (Fig. 4-1), *Mallotus* (Fig. 4-3), the European Oligocene *Enoplophthalmus* and the North American Paleocene *Speirsaenigma* (McAllister, 1963; Gaudant & Burkhardt, 1984; Gaudant, 1985; Wilson & Williams, 1991). In the structure in the anal fin of presumed males, the present species is similar to *Spirinchus lanceolatus* (Pacific coast of Hokkaido), *Mallotus villosus* (cool and boreal seas in the Northern Hemisphere) and *Speirsaenigma lindoei* (the Paleocene Paskapoo Formation, Alberta, Canada) in particular. Among them, it is most similar to *Spirinchus lanceolatus* with the most enlarged and thickened fin rays and proximal pterygiophores within all the osmerids so far nominated (Figs. 1, 3, 4-1). It does, however, differ from the latter in the number of vertebrae (about 48–50 vs. 60–65 in *Spirinchus lanceolatus*, data from Hosoya, 1993). Furthermore, in males, they are distinguishable from each other in the mode and arrangement of proximal pterygio-

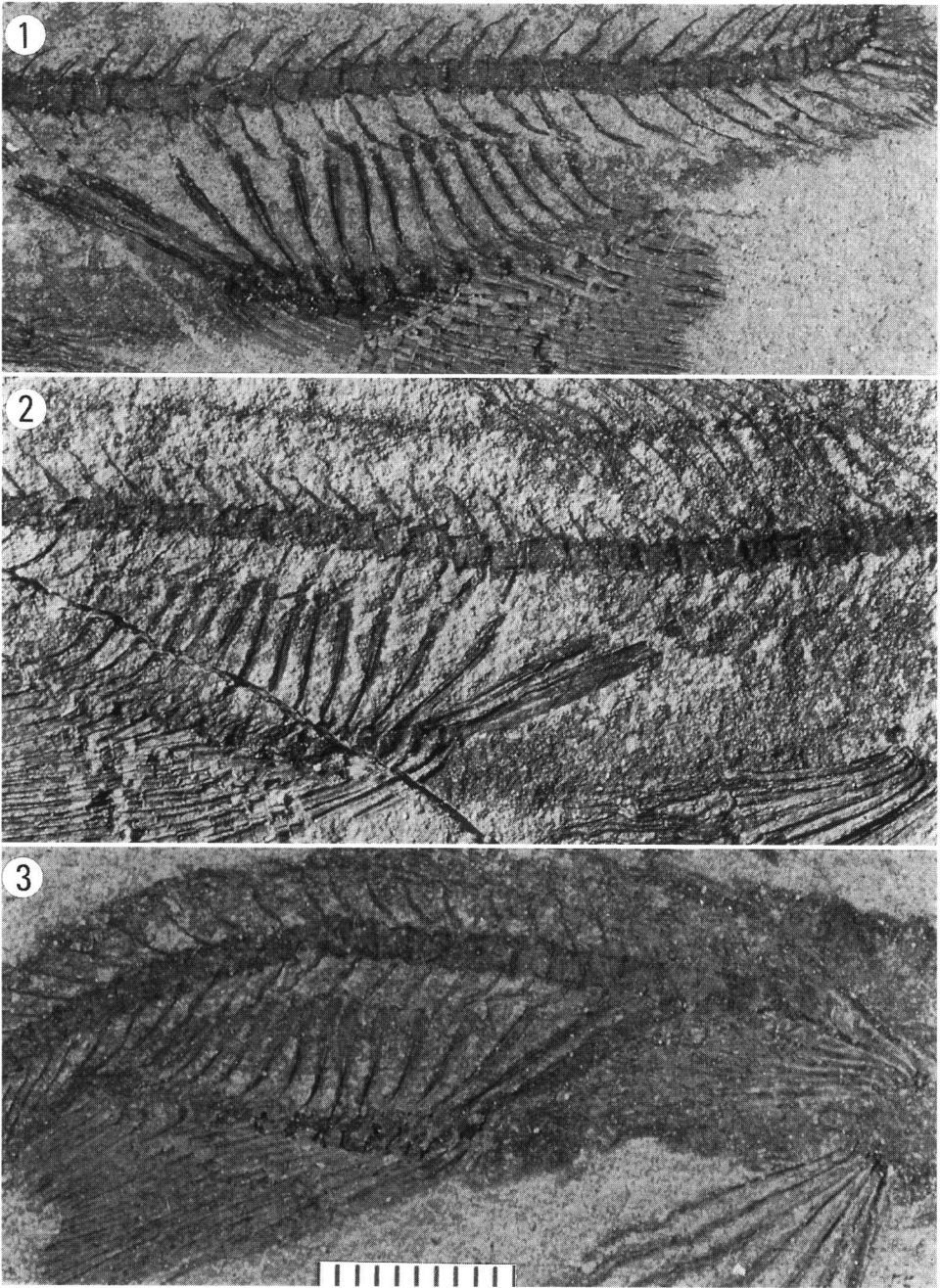


Fig. 3. Caudal region of *Spirinchus akagii* sp. nov. 1, 2 (counterpart), holotype, TRPM 664-062, presumed male. 3, Mr. Toshiteru Maruo collection No. 13, presumed male.

phores of the anal fin and the relation between the lengths of the proximal pterygiophores and their associated haemal spines. In the present species, anterior proximal pterygiophores are not arranged parallel to each other, but are all arranged almost parallel to each other in *Spirinchus lanceolatus* (Figs. 1, 3, 4-1). The ratio of the length of the proximal pterygiophore to its associated haemal spine at the middle part of the anal fin is about 2:1 in the present species and around 2.6:1 in *Spirinchus lanceolatus*.

The present species is distinguishable from *Mallotus villosus* in having about 48–50 vertebrae (vs. 62–73 in the latter, data from Hosoya, 1993), eight pelvic fin rays (vs. nine, data from McAllister, 1963) and anterior proximal pterygiophores of the anal fin rays not arranged parallel with each other in males (anteriorly arranged parallel to each other in both sexes, although posterior ones not parallel to the others) (Figs. 1; 3; 4-3, 4), and in the ratio of the length of the proximal pterygiophore to its associated haemal spine at the middle part of the anal fin in males (about 2:1 vs. about 1.5:1).

The present species resembles *Speirsaenigma lindoei* in having about 48–50 vertebrae in addition to the structure in the anal fin in males. However, it is easily distinguished from the latter by the number of anal fin rays (16–17 vs. about 21, data from Wilson and Williams, 1991) and the position of the pelvic fin relative to the dorsal fin. The origin of the pelvic fin is in advance of that of the dorsal fin in the present species (Figs. 1, 2, 3), and slightly posterior to that in the latter (Wilson & Williams, 1991).

Diagnostic characters for the osmerid genera given by McAllister (1963) and Wilson and Williams (1991) could not be observed in the present fossil specimens. Also, sexual dimorphism in the anal fin is considered to occur independently in several osmerid lineages (see McAllister, 1963; Wilson & Williams, 1991). Nevertheless, we concluded that it is reasonable to classify the present species into the genus *Spirinchus* and unwise to erect a new genus to accommodate it, because it is more similar to *Spirinchus lanceolatus* than to any other osmerid in its sexually dimorphic anal fin in presumed males, and because no characters are available to establish a new genus.

On the basis of these considerations, we described the present species as a new species in the genus *Spirinchus*.

Comparative materials: *Spirinchus lanceolatus*, ZUMT (Department of Zoology, University Museum, University of Tokyo) 61138–61143, 140–165 mm TL, 3 males and 3 females, off Kushiro, Pacific coast of Hokkaido, Japan, Nov. 1997. *Mallotus villosus*, HUMZ (Laboratory of Marine Zoology, Hokkaido University) 85658, 85743, 85748, 85750, 85888, 145–160 mm TL, 3 males and 3 females, eastern Bering Sea, July 1979.

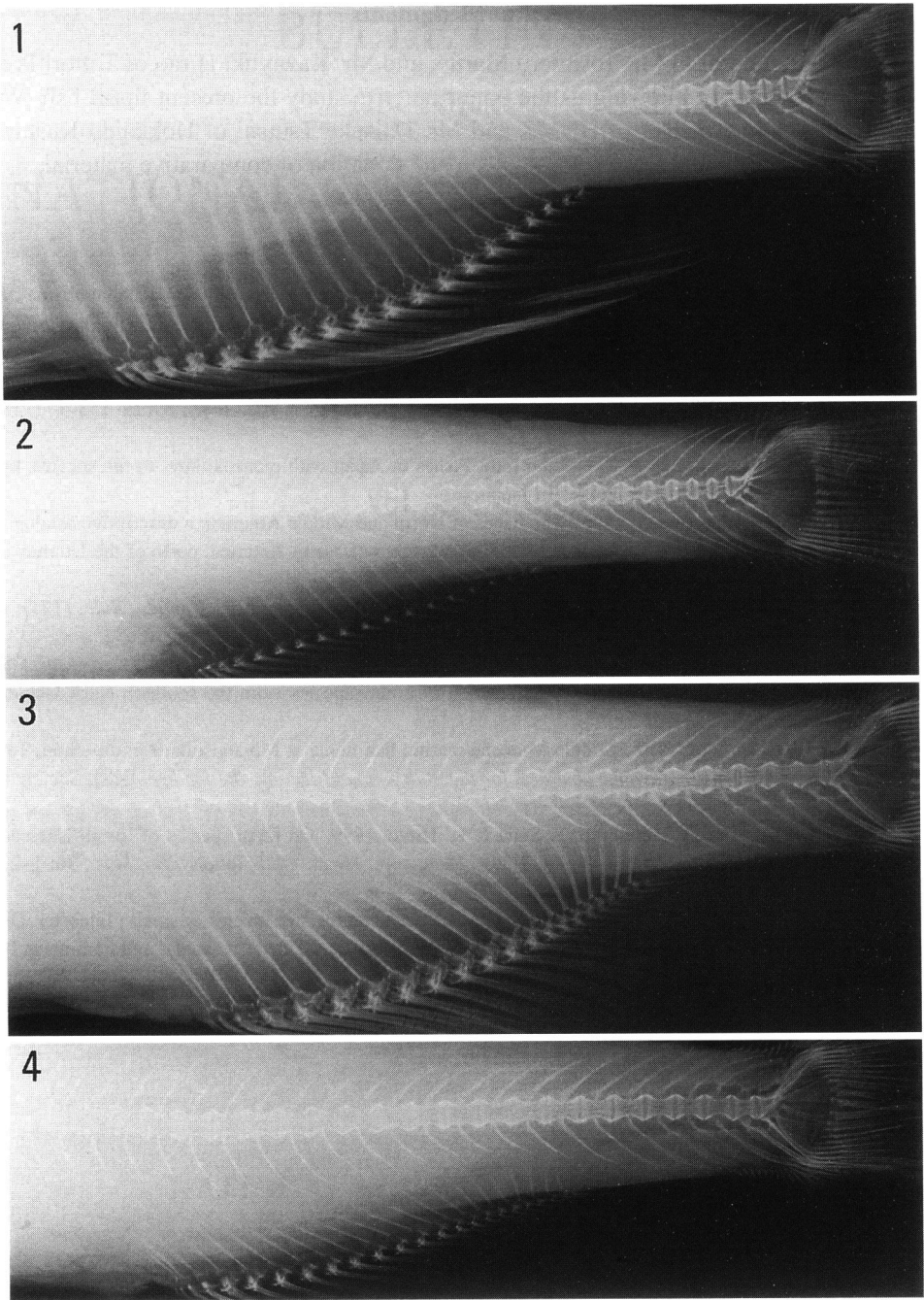


Fig. 4. X-ray photographs of caudal region of two osmerid fishes. 1, 2, *Spirinchus lanceolatus*, 1: ZUMT 61139, male, 150 mm in total length, 2: ZUMT 61141, female, 133 mm in total length. 3, 4, *Mallotus villosus*, 3: HUMZ 85743, male, 157 mm in total length, 4: HUMZ 85888, female, 150 mm in total length.

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