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Early Triassic Ichthyosaurus, *Utatsusaurus hataii* Gen. et Sp. Nov., from the Kitakami Massif, Northeast Japan

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and
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ABSTRACT

A new Early Triassic ichthyosaurus, *Utatsusaurus hataii* gen. et sp. nov., is described. The materials were collected from the upper part of the Osawa Formation on the coast at Tatezaki, the Kitakami Massif, Northeast Japan which is correlative of the Prohungaritan-Columbitan ammonoid stages of Spath (1930, 1934). The present form is of the most primitive type of Ichthyosauria from the view point of specialization of the pectoral limb.

INTRODUCTION

On the 4th of September, 1970, many fragmental skeletons of several individual reptiles, including a lower jaw, were found from the Early Triassic Osawa Formation, exposed along the coast of Tatezaki, Utatsu-cho, Motoyoshi-gun, Miyagi Prefecture, by four members of the Working Group of the Permian-Triassic Systems in Japan (Drs. Yuji Bando, Ken-ichi Ishii, Keiji Nakazawa and Masafumi Murata, the junior author). At that time, they were reexamining the Late Permian and Early Triassic formations in the Kitakami Massif in order to settle the Permian-Triassic boundary problems. The reptilian skeletons were scattered in the shale beds and exposed on a weathered surface of the rocky shore. During the additional stratigraphical study carried out by M. Murata in early October, 1970, preceding the excavation of the reptilian fossils, a dozen or more crowds of reptilian skeletons were found from several horizons ranging over 200 m in the middle and upper parts of the Osawa Formation with some ammonoids and plant remains.

After five days of stratigraphic study by M. Murata from the 12th to 16th of December, the reptilian remains have been excavated by the staffs and members of the Institute of Geology and Paleontology, Tohoku University, in associations with the present authors and the local people. Five main specimens and several other fragmental materials were collected from localities E to N shown in Figs. 4 and 5.

As a result of a paleontological study, the present form is described as new to science, and a new generic name *Utatsusaurus* is proposed. *Utatsusaurus hataii* gen. et sp. nov. was collected from the lowest horizon of ichthyosaurus, Late Scythian in age, as nearly the same as the lowest horizon of *Grippia* Wiman (1928, 1933) described from Spitzbergen, and is distinctive as having the most primitive form of pectoral limb of any

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known species of the Ichthyosauria. Thus the present new species holds an important position in the phylogenic evolution of the Ichthyosauria.

The present work was partly carried out by the junior author (M.M.) during his tenure at the Institute of Geology and Paleontology, Tohoku University.

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STRATIGRAPHICAL NOTE ON THE OSAWA FORMATION

In general, the Mesozoic formations in the southern part of the Kitakami Massif comprise two major synclines with N-S to NNE-SSW trend and plunging southward: the eastern one is called the Karakuwa-Oshika Syncline and the western one the Motoyoshi-Ishinomaki Syncline, being separated by the Kesennuma-Okatsu Anticline. The Early to Middle Triassic Inai Group rests on the Late Permian (Dzhulfian) Toyoma Formation with a distinct unconformity, and is covered with clinounconformity by the Late Triassic Saragai Group (Carno-Norian) or the Early Jurassic formations. The Inai Group, which is distributed in the synclinal structures, comprises four formations, the Hiraiso, Osawa, Fukkoshi and Isatomae formations, in ascending order, and represents two megacycles of sedimentation; the Hiraiso and Osawa formations are in the lower, and the Fukkoshi and Isatomae formations in the upper cycle. Each formation of the Inai Group shows rather uniform lithofacies over the distributed area, but varies in thickness with area.

The Hiraiso Formation consists of a thick conglomerate and alternations of sandstone

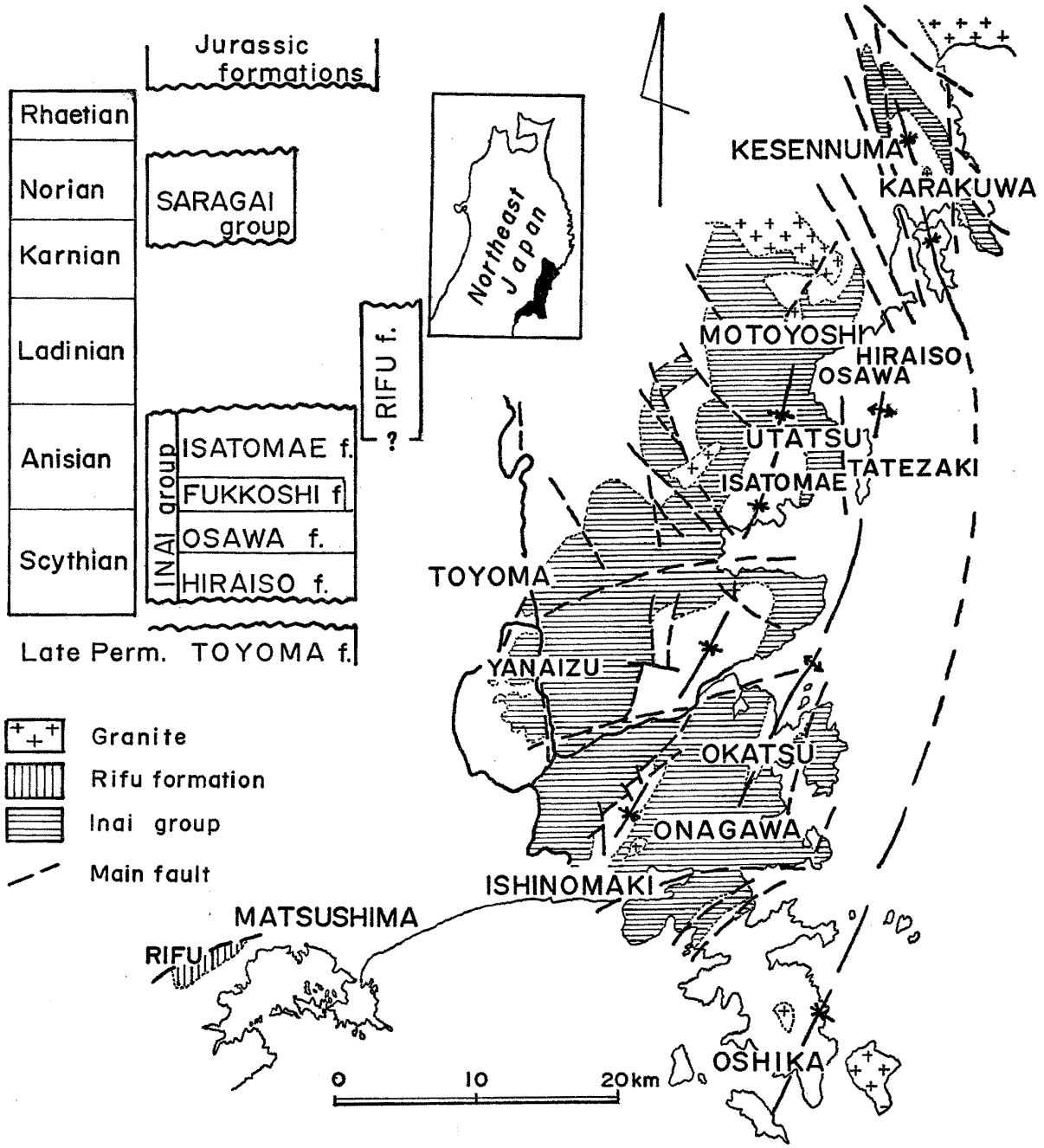

Fig. 1. Distribution of the Inai Group.

and conglomerate in the lower part, and an alternation of predominated calcareous sandstone and shale in the upper part. Along the western margin of the formation, the basal part of the formation is intercalated locally with thin beds of acidic tuff. Coarse-grained sediments in the lower part of this formation are distributed in the southern area, and thinning toward north or north-northeast. The Osawa Formation gradually changes in its lithofacies upward from the Hiraiso Formation, and is composed of a thin alternation of predominated shale and calcareous fine-grained sandstone. This formation represents a muddy flysch-like facies, in which the trace of paleocurrents from the south or south-southeast prevailed. In the southern area, features of slumping are observed in the

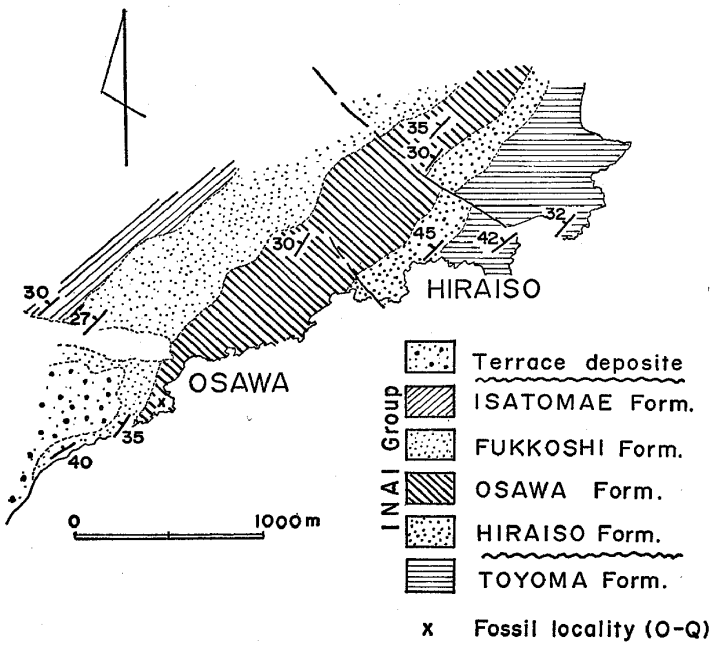

Fig. 2. Distribution of the Osawa Formation in the Motoyoshi Area.

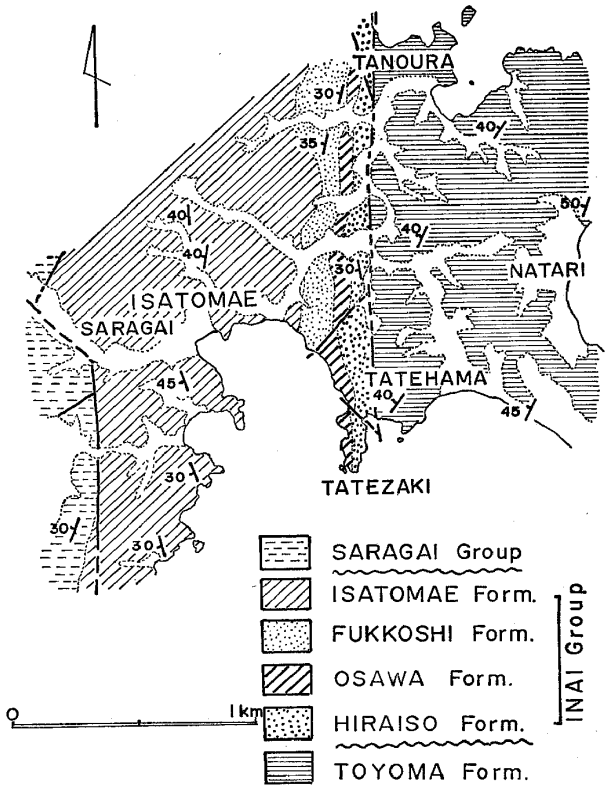

Fig. 3. Distribution of the Osawa Formation in the Utatsu Area.

lower part of the Osawa Formation. The Fukkoshi Formation consists of thick-bedded or massive sandstone intercalated with thin layers of shale and lenticular pebbly conglomerate. The lithology changes laterally into the lower part of the Isatomae Formation (Ichikawa, 1951; Onuki and Bando, 1959; Bando, 1964), well bedded calcareous sandstone and shale, amounting to 1500 m.

Geology of the Osawa area and fossil localities are shown in Figs. 2, and 5. Along the coast of Osawa, Motoyoshi-cho, Motoyoshi-gun, Miyagi Prefecture, the type section of the Osawa Formation, 350 m in thickness, is exposed continuously, and some poorly preserved skeletons of *Utatsusaurus* were collected from three horizons (O-Q) in its upper part. Most specimens of *Utatsusaurus hataii* gen. et sp. nov., including the holotype, were collected from the coast of Tatezaki, Utatsu-cho, Motoyoshi-gun, about 10 km south of Osawa. Here the Osawa Formation overlies a thick-bedded rather coarse-grained sandstone at the top of the Hiraiso Formation in the east, and contacts with a massive medium-grained sandstone of the Fukkoshi Formation in the west by a fault. The Osawa Formation, cropping out on the coast of Tatezaki, consists of a thin alternation of dark gray shale and calcareous fine-grained sandstone with several beds of medium- to coarse-grained sandstone of 1.5 m in maximum thickness. Localities and horizons of *Utatsusaurus hataii* gen. et sp. nov. are shown in Figs. 4 and 5 as A-N.

FOSSIL RECORDS AND GEOLOGICAL AGE OF THE OSAWA FORMATION

Faunas of the Osawa Formation from several localities have been recorded only in the lists by Shiida (1940), Inai and Takahashi (1940), Ichikawa (1951), and Onuki and

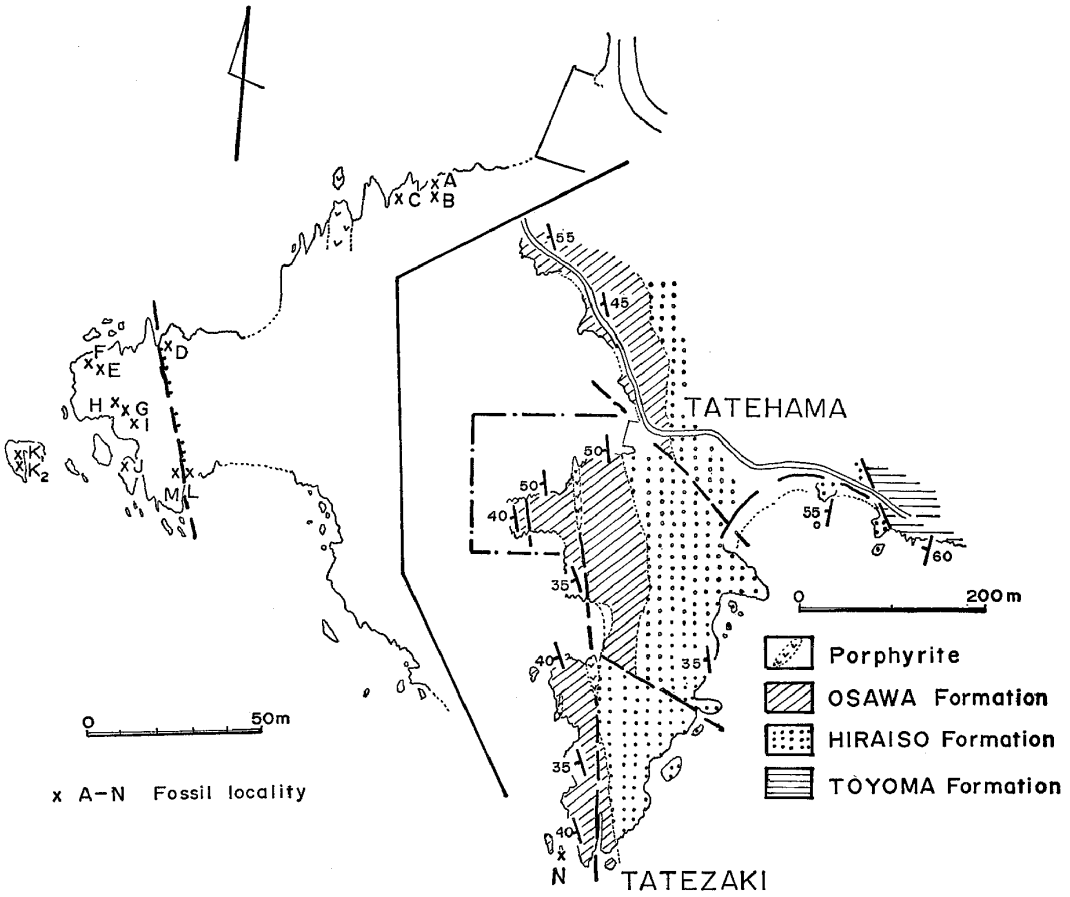

Fig. 4. Distribution of the Osawa Formation and localities of *Utatsusaurus hataii* at Tatezaki, Utatsu-cho, Motoyoshi-gun, Miyagi Prefecture.

Bando (1959), except for the descriptions and illustrations of *Conulariopsis quadrata* by Sugiyama (1942) and *Metanothosaurus nipponicus* by Yabe and Shikama (1948).

Ichikawa (1951) listed the following fossils from the upper part of the Osawa Formation at the type section exposed along the coast at Osawa:

"*Ophiceras*" sp.	"*Senodiscus*" spp.
Prohungaritoid ammonite	Pseudoharpoceroid ammonite
Eumorphotis aff. *telleri* (Bittner)	*Posidonia* spp.
Nuculopsis (*Palaeonucula*) ? sp.	

"*Ophiceras*" ? sp. was also listed by Inai and Takahashi (1940) and Ichikawa (1951) from this formation distributed to the east of Okatsu, Okatsu-cho, Mono-gun, Miyagi Prefecture.

Recently, rich faunas of ammonoids (Bando, 1970; Bando and Shimoyama, 1974), bivalves and brachiopods (Murata, 1973) and flora (Kon'no, 1973) have been described from the Osawa Formation exposed at Osawa, Tatezaki and many other localities.

In the correlation of the Osawa Formation, the most important fossils are ammonoids. Bando (1970) described *Flemingites* sp., *Euflemingites* sp., *Meekoceras* spp., *Xenoceltites* ? sp. and *Danubites* sp. from the type section of the Osawa Formation on the coast at Osawa, Motoyoshi-cho, Motoyoshi-gun, Miyagi Prefecture and *Leiophyllites* cf. *pitamaha* (Diener), *Leiophyllites* aff. *pradyumna* (Diener), *Danubites* aff. *ambika* Diener and *Danubites* sp. from the lowermost part of the Fukkoshi Formation exposed at the quarry of Konori, near Konorihama, Onagawa-cho, Oshika-gun, Miyagi Prefecture.

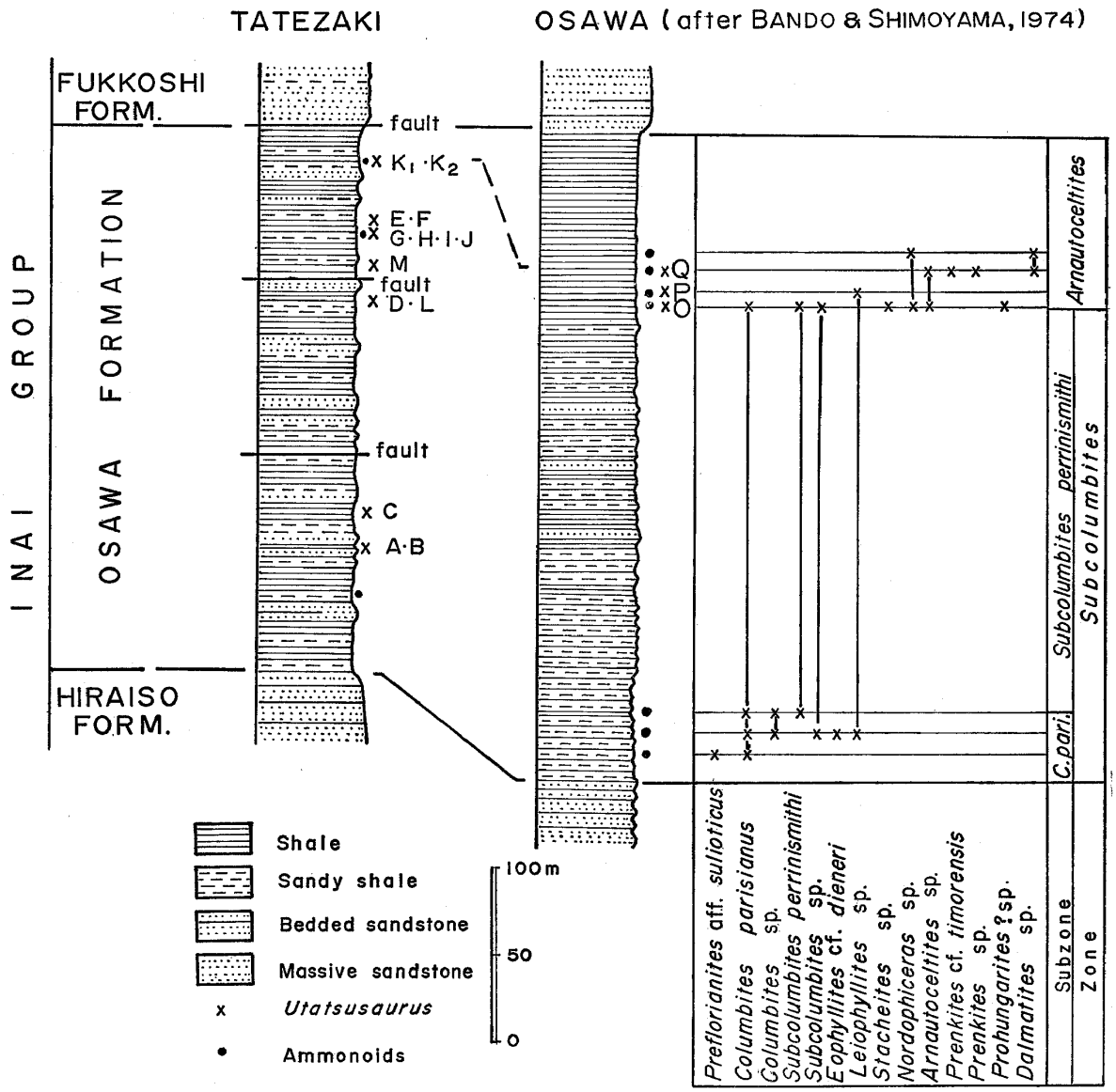

Fig. 5. Columnar sections and faunal occurrence of the Osawa Formation in the Utatsu and Motoyoshi areas.

According to biostratigraphical and paleontological studies on the ammonoids by Bando and Shimoyama (1974), the Osawa Formation includes the *Subcolumbites* Zone in its lower and middle parts, and the *Arnautoceltites* Zone in the upper. The *Subcolumbites* Zone is subdivided into *Columbites parisianus* Subzone and *Subcolumbites perrinismithi* Subzone. Described by them are;

Subcolumbites Zone

Columbites parisianus Subzone

Preflorianites aff. *sulioticus* (Arthaber)
Columbites parisianus Hyatt and Smith
Subcolumbites perrinismithi (Arthaber)
Eophyllites cf. *dieneri* (Arthaber)
Leiophyllites sp.

Subcolumbites perrinismithi Subzone
Columbites parisianus Hyatt and Smith
Subcolumbites perrinismithi (Arthaber)
Stacheites sp.
Eophyllites sp.
Leiophyllites sp.
Arnautoceltites Zone
Arnautoceltites sp.
Isculitoides aff. *originis* (Arthaber)
Prenkites cf. *timorensis* Spath
P. sp.
Dalmatites sp.

On the basis of their paleontological study, Bando and Shimoyama (1974) correlated the Osawa Formation with the Late Scythian Columbitan – Prohungaritan of Spath (1930, 1934).

The localities (A-P) of *Utatsusaurus hataii* gen. et sp. nov. are within the *Subcolumbites perrinismithi* Subzone and the *Arnautoceltites* Zone of Bando and Shimoyama (1974) (Fig. 4).

SYSTEMATIC DESCRIPTION

Order Ichthyosauria
Family Omphalosauridae

Genus *Utatsusaurus* Shikama, Kamei and Murata, gen. nov.

Generic Diagnosis: – Small-sized archetypal ichthyosaurus related closely to *Grippia* Wiman (1928). Skull small, with large orbit contented screlotic ring, relatively low cranium and short snout. Teeth long, acute and pleurodont. Vertebrae have long neural spines and amphicoerus centra. Costal articulation with vertebra double. Costa and phalange long and slender. Manus has five digits. Scapula and coracoid spatulate. Humerus, ulna, radius, metacarpus relatively long. Aft limb rudimentary.

This genus is distinguished from *Grippia* Wiman (1928) by longer and more acute teeth with longitudinal striations, and relatively longer ulna and radius. *Pessopteryx* Wiman (1909), *Cymbospondylus* Leidy (1868), *Mixosaurus* Baur (1887), *Shastasaurus* Merriam (1895) and *Californosaurus* Kühn (1943), etc. are easily distinguishable by more specialized fore limb.

Utatsusaurus hataii Shikama, Kamei and Murata, gen. et sp. nov.
Pls. 1–9; Figs. 6–12

Diagnosis: – Body small, longer than 140 cm in restored length, and about 22 cm in dorsal width. Skull rather small, 20 cm long and 7 cm wide, with low cranium and short snout. Aft limb small and rudimentary. Dorsal region about 50 cm long and 22 cm wide, and caudal region about 50 cm long with caudal fin of nearly 30 cm in length. Cervical region not so short as that of *Cymbospondylus* Leidy (1868). Teeth long and acute. Costa and phalange rather long and slender. Metacarpus distinctly long.

Lachrymal and postorbital well developed; jugal thick and stout; orbit relatively large. Screlotic ring developed with seven segments. Lower jaw narrow and long with gently curved dentary; suprangular developed more distinctly than angular; alveole not deep with about 40 pleurodont teeth. Vertebrae carry amphicoerus centra which is relatively

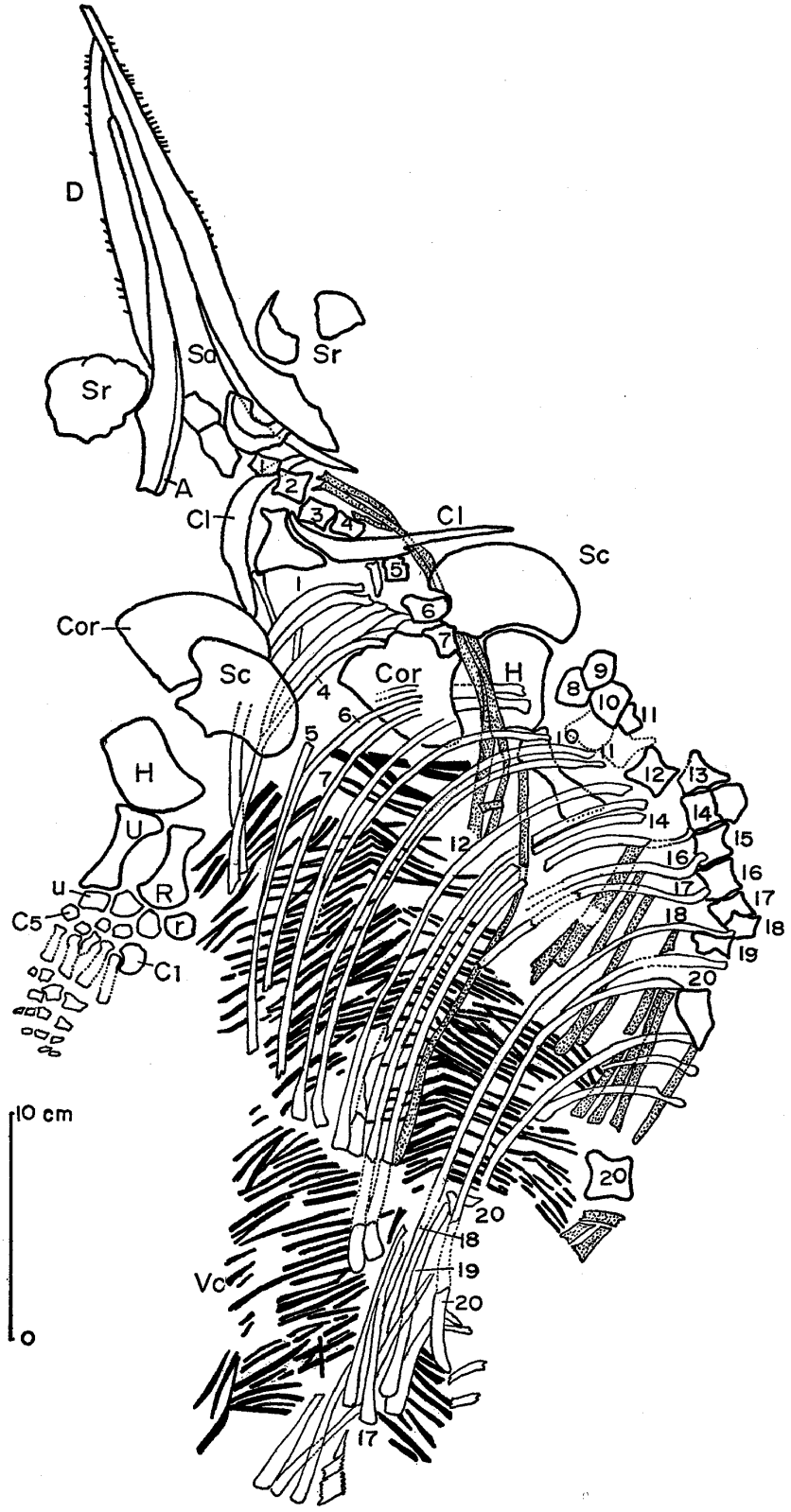

Fig. 6. *Utatsusaurus hataii* gen. et sp. nov., holotype, specimen No. K_1.
A: Angular, C_{1-5}: 1st to 5th Carpal, Cl: Clavicle, Cor: Coracoid, D: Dentary, H: Humerus, I: Interclavicle, R: Radius, r: Radiale, Sa: Suprangular, Sc: Scapula, Sr: Scrolotic Ring, U: Ulna, u: Ulnare, Vc: Abdominal Costae (Ventral Costae).

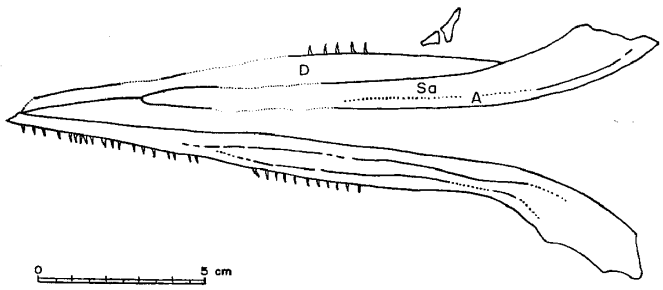

Fig. 7. Ventral side view of lower jaw.
A: Angular, D: Dentary, Sa: Suprangular

long in anterior and short in posterior portions; about 30 in number in caudal region and more than 20 in dorsal. Neural spine long, elongate quadrate, and running opposite to each other at anterior end of caudal fin. Costae slender, long, and twisted at proximal portion, with expanded distal end. Scapula spatulate, distinctly expanded distally; distal margin eminently curved. Coracoid also spatulate with projected proximal extremity; distal margin more eminently curved than that of scapula. Interclavicle trigonal with both projected lateral and proximal ends; both lateral margins gently curved and concave outward. Clavicle lanceolate, elongate, gently curved; distal end sharply projected. Humerus robust, quadrate in outline, rather short, with straight proximal margin and curved inner and outer margins. Ulna and radius well developed, long, with expanded proximal and distal ends. Ulnare, intermedium and radiale subquadrate, and not jointed with each other. Five metacarpal distinctly long, much longer than phalange, elongate quadrate, with expanded distal end. Phalange of manus very short, wider than long and quadrate in outline. Pelvis much smaller than pectoral girdle. Ilium small, slender and columnar. Pubis and ischium spatulate, expanded distally; ischium corresponds to posterior dorsal vertebra in size. Femur elongate quadrate, with expanded proximal end. Tibia and perone elongate quadrate or columnar, with expanded proximal margin.

Materials: – The present species is based on 13 specimens, numbered E, F, G, I, J, K_1, K_2, L, M, N, O, P and Q. The numbers of the specimen correspond to the localities in Figs. 3, 4 and 5. Among them, the specimens of Nos. E, K_1, K_2 and L are rather well preserved and represent characteristic features of this new species; No. E retains posterior portion of vertebrate column and aft limbs; Nos. K_1 and K_2 are lower jaw, anterior portion of vertebrate column and costae, and fore limb; No. L is caudal region of vertebrate column.

No. K_1 (holotype): The specimen represents ventral side of skull, left side of vertebrate column and costae, dorsal side of left and right limbs (Plates 1, 2; Figs. 6, 7).

Cranium obscure, but dentary angular and suprangular well preserved (Fig. 7). Two sclerotic rings preserved, close to proximal portion of suprangular. Three bones of basioccipital exist, inside of angular. Twenty vertebrae visible; from 1st to 7th vertebra preserved in nearly original portion, from 8th to 19th jointed with each other in original portion, and 20th separated. Twenty-three costae of left side observed, arranged in original portion; from 12th to 19th costa jointed with corresponded vertebra, and anterior 1st to 11th and posterior four costae from 20th to 23rd separated from original position. About 14 costae of right side preserved under left side costae. Ventral costae shown inner side in original arrangement. Dorsal side of right fore limb of scapula, coracoid, humerus and ulna observed in anterior portion of thoracic region, jointed with each other. Dorsal side of right carpal and metacarpal bones, and phalanges also arranged in original position, jointed with each other. Dorsal side of left scapula, coracoid, humerus,

ulna and radius preserved under left costae.

Cadaver may be twisted at cervical portion, and both fore limbs detached; then, ventral side of skull, dorsal side of limbs, and posterior side of clavicles and interclavicle attached to left side of costae and vertebrate column.

No. K_2: This material represents ventral side of skull with lower jaw, left side of thoracic region, dorsal side of right fore limb, a part of left fore limb, and vertebrate column (Plate 3, figs. 1–3).

Outline of cranium uncertain, but a part of it observed clearly beside right sclerotic ring. Right and left sclerotic rings preserved in both sides of right lower jaw. Inner side of ventral costae overlapped by left costae in original arrangement. Dorsal side of right scapula, coracoid, humerus, ulna, radius, carpal and metacarpal bones perderved, and jointed with each other. Left coracoid preserved, showing dorsal side.

The cadaver may be twisted at cervical portion, and detached right fore limb from thoracic region. Ventral side of lower jaw and left side of thoracic region preserved in same lamina. It may be significant that the mode of cadaver setting in sedimentary layer is quite similar to that of No. K_1 specimen. It may have originated from a characteristic construction of anterior portion of this species.

No. E: The material represents right side of posterior portion of vertebrate column (Plate 4). Thirty-one vertebrae retained. Detached ilium, ischium, pubis, femurs on both sides, tibia and fibula scattered in posteroventral corner.

No. F: Five jointed vertebrae and costae, seven vertebrae showing their left side, and five or more detached costae from column separated with one another (Plate 8, fig. 4). A part of ventral costae preserved. Imperfect right radius and carpals observed.

No. G: The specimen represents undislocated anterior vertebrate column showing right side of about 16 vertebrae. Twenty costae preserved in original arrangement, and 12 of them jointed with their corresponded vertebrae (Plate 6).

No. I: Imperfect specimen of dentary bone, about 90 mm long and about 10 mm high, probably represents a posterior portion of dentary. Characteristic features of dentary bone and long and slender teeth rather well preserved (Plate 9, figs. 1–3).

No. J: Lower jaws of both sides and vertebrate column of five vertebrae showing their left side observed. About 14 detached costae and a portion of both fore limbs of both coracoids and scapulas, left ulna and left radius preserved. Left carpal and metacarpal bone also retained (Plate 7, figs. 1 and 2).

No. L: The specimen represents left side of caudal region (Plate 5). Twenty-three caudal vertebrae jointed with each other. Neural spines of 10th and 11th vertebrae opposed to each other, hence posterior side from 11th vertebra corresponds to caudal fin.

No. M: About 14 costae of right side arranged in original position, but not jointed with vertebrae. Some ventral costae observed.

No. N: Right side of neural spines of vertebrae is in original position, and closely attached to each other: almost five vertebrae visible, but seven vertebrae observed in external mold of the same specimen (Plate 8, figs. 1, 2).

No. O: A right costa, a right humerus and probably a left humerus preserved (Plate 8, fig. 3).

No. P: A caudal vertebra preserved (Plate 7, fig. 4).

No. Q: Orbital region of skull, retaining jugal, frontal and postorbital bones; dislocated lachrymal and frontal bones preserved in orbit (Plate 7, fig. 3; Fig. 9).

Description :–

Skull: Cranium invisible of its outline, but a part of orbital region preserved in Specimen No. Q. General size and aspect can be assumed by arrangement of lower jaws of

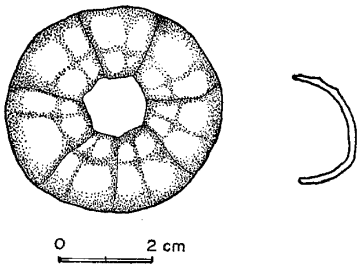

Fig. 8. Screlotic ring and cross section of a piece.

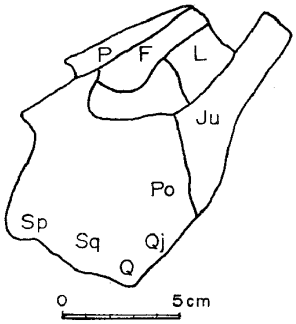

Fig. 9. Orbital region of skull of Specimen No. Q.
F: Frontal, Ju: Jugal, L: Lachrymal, P: Parietal, Po: Postorbital, Q: Quadrate, Qj: Quadratojugal, Sp: Supratemporal, Sq: Squamosal.

Specimens Nos. K_1 and K_2. Orbital and postorbital regions rather short while snout relatively long. Orbit large, suboval and contented screlotic ring inside of it. Maxilla, premaxilla and nasal uncertain in outline but seem to be relatively long and low. Jugal subquadrate, gradually becoming broader and higher posteriorly; posterior margin straight, upper and lower margins gently curved. Lachrymal relatively large, and quadrate. Parietal and frontal elongate quadrate with gently curved upper and lower margins, becoming gradually wider posteriorly. Postorbital rather large, subquadrangular with much curved anterior margin. Squamosal, supratemporal, quadrate and quadratojugal obscure in outline; relatively small and subquadrangular.

(in mm)	Parietal	Frontal	Lachrymal	Jugal	Postorbital	Squamosal	Quadrate
Max. length	48.0	33.1	23.4	54.6±	57.3	24.9±	25.8±
Max. width	10.5	16.0	18.3	30.9	59.7	25.8±	7.1

Screlotic ring preserved in Specimens Nos. K_1 (holotype) and K_2, although detached from original position, and depressed in dorso-ventral direction. Right ring of holotype subcircular in general outline, composed of jointed pieces; precise shape of piece uncertain. Anterior margin of ring undulated. Left ring of holotype separated into two parts of trigonal and crescentic forms. Both rings of Specimen No. K_2 also separated into two parts respectively. Crescentic bone may be lateral side of a piece set overlapping successively. Rings of Specimen No. K_2 curved moderately along interior and exterior margins, and their surface depressed eminently near exterior margin (Fig. 8). Diameter of ring 40.5×38.0 mm in holotype, and 42.2×36.9 mm in Specimen No. K_2. Dimensions of a piece of ring in Specimen No. K_2 as follows:

(in mm)	Right	Left
Length	40.3	43.6
Width	18.2	22.4

Lower jaw: Dentary, suprangular and angular preserved in two specimens of Nos. K_1 (holotype) and K_2. Specimen No. I represents posterior portion of dentary. Lower jaw relatively long and narrow. Dentary well developed, as long as suprangular, almost straight in running; thickest at a point about one third from posterior end, and narrowing gradually to anterior (Fig. 7). Inner side of dentary of posterior two-thirds length closely set with outer ridge of angular of anterior two-thirds. In lateral view, dentary elongate lanceolate with gently curved dorsal and straight ventral margins; suprangular elongate

trigonal with broadest posterior end, and narrowing to anterior end, dorsal and ventral margins gently curved; angular narrow and elongate, closely set with ventral portion of suprangular. Surface of dentary, suprangular and angular ornamented with finely striated grooves, which are usually characteristic in reptilian skeletons.

(in mm)		No. K_1 (holotype) Right	No. K_1 (holotype) Left	External mold of No. K_1 Right	External mold of No. K_1 Left	No. K_2 Right	No. K_2 Left	External mold of No. K_2 Right	External mold of No. K_2 Left
Dentary	Max. length	149.3*+	146.5*±	155.0±	143.6	–	–	–	58.6+
	Max. width	12.1*	13.3*±	11.8±	24.3±	–	–	–	–
Supragular	Max. length	154.2±	138.3±	138.0±	123.1*+	116.2*±	119.9*±	73.8+	128.5
	Max. width	10.8±	14.6±	14.0±	18.0*	20.4*	12.8	16.0	19.5
Angular	Max. length	–	–	71.3±	–	82.5*	69.0±	–	120.0+
	Max. width	–	4.0	5.0	–	4.8*	3.8±	–	8.0

* Most reliable measurement.

Most reliable measurement shows dentary 149.3×13.3 mm, suprangular 123.1×20.4 mm, and angular 82.5×4.8 mm. Lower jaw reaches 215 mm in total length in holotype.

Teeth: On dentary of Specimen Nos. K_1 (holotype) and I acutely pointed thin conical teeth set. In holotype specimen, toothrows about 150 mm, 32 teeth observed on left dentary and five teeth on right one, however, number of teeth ranges from 40 to 45 from radiograph; teeth arranged more closely and more crowded anteriorly than posterior portion, and smaller in anterior portion. In this connection, though only three teeth implanted on fragmental dentary with a distance of 30 mm, Specimen No. I presumed to be a posterior portion of dentary.

Apex of teeth commonly acutely pointed like a needle, and crown conical to cylindrical, sharply projected and posterior margin tolerably curved backward. Height of tooth about 7 mm in exposed position, and nearly 1 mm in diameter at base, however, basal part of tooth extends into pit of alveoli, and whole length attains up to 10 mm. Enamel folding regularly arranged, and rather strongly ornamented on surface of crown along longitudinal axis of tooth (Plate 9, fig. 2). Pulp cavity smoothly walled, and base has no radial folding of enamel. Enamel very thin and no tooth cementaum. Pulp cavity looks like bone shape with flattened basal aperture. Outer layer of pulp cavity appears sharp lined at predentine and dentine junction, and it may depend on calcification.

Each tooth has single alveoli, calcified as judged from radiograph. Between those single alveoli, unerupted successive teeth germs, not calcified, are interposed alternatively (Plate 9, fig. 3). Therefore, tooth replacement might alternate and be gradual in rear part of dentary. However, crowded teeth on aft part of dentary in holotype specimen show rapid replacement of teeth in anterior portion.

Vertebrae: Twenty vertebrae preserved on holotype specimen, of which anterior 11 dislocated more or less from their original positions, and 20th vertebra isolated from antecedent vertebrae. Vertebrate column of dorsal region gently curved and 26.2 cm in united length from 1st to 20th vertebrae. Most of them show their left lateral side.

Vertebrate column of Specimen No. E 49.7 cm long, consists of more than 28

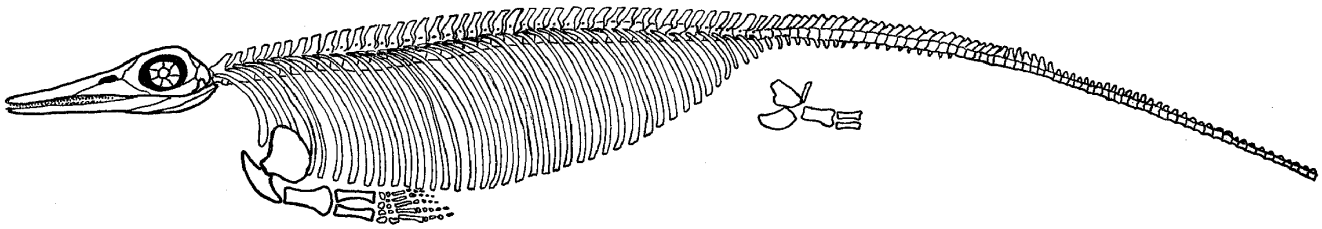

Fig. 10. Left side view of skeleton of *Utatsusaurus*.

vertebrae, showing their right lateral side, associated with pelvic bones and short costae. This column corresponded with lumbar, pelvic and proximocaudal regions. Pre-pelvic column 28.7 cm long and post-pelvic 21 cm, running almost straight. Five serial neural spines jointed with posterior portion of vertebrate column.

Vertebrate column of Specimen No. G 40 cm long, consists of 20 vertebrae showing right lateral side, with costae; anterior six vertebrae obscure, and median four and posterior three vertebrae in association with serial neural spines.

Longitudinal length of body estimated from each specimen as follows:

(in cm)	K_1	E	L
Skull	21.5		
Cervic region	8		
Thoracic region	18.2		
Lumbar region		28.7	
Caudal region		21	46
Caudal fin			20

Centrum of all vertebrae platycoerus or slightly amphicoerus. In lateral view, centrum generally quadrate in outline, longer than high in lumbar-caudal region, nearly same length as height (holotype specimen) or higher than long (No. G) in thoracic region. Dorsal and ventral margins gently curved; tubercular and capitular facettes for costae lying in median ventral portion rather obscure in outline.

Dimensions:

Specimen No. K_1 (Holotype)

	Cervic						
(in mm)	1	2	3	4	5	6	7
Long. length	8.2±	11.2±	10.7	11.4	12.5	10.3	8.9
Max. height	10.5	11.9	13.0	9.8	11.5	16.4	14.8

	Dorsal											
8	9	10	11	12	13	14	15	16	17	18	19	20
14.2±	12.1±	14.5±	13.0±	16.0±	14.7±	16.5±	12.5±	14.8±	10.3±	10.5±	11.0±	16.7±
16.1	16.7±	17.5±	12.0±	16.4±	16.9±	14.9±	17.4±	16.8±	16.9±	13.2±	15.1±	18.5±

Specimen No. E

	Dorsal												
(in mm)	1	2	3	4	5	6	7	8	9	10	11	12	13
Long. length	13±	13±	12±	17±	17±	15±	–	–	–	17±	17±	17.5±	17±
Max. height	10±	12±	15±	17±	15±	20±	–	–	–	11±	17±	17±	20±

14	15	16	17	18
17±	20±	18±	17±	18±
20±	21±	20±	18±	18±

Caudal

1	2	3	4	5	6	7	8	9	10	11	12	13
21±	18±	18±	18±	20±	20±	20±	20±	20±	25±	23±	18±	10±
18±	18±	18±	18±	20±	20±	18±	20±	20±	23±	20±	18±	17±

Specimen No. L

Caudal

(in mm)	1	2	3	4	5	6	7	8	9	10
Long. length	24.8	27.8	25.2	23.5	21.2	24.9	22.0	22.8	26.7	19.2
Max. height	23.9	23.9	23.7	26.7	25.7	28.1	21.1	24.5	22.9	23.1
LN	17.4	14.7±	10.3+	12.3	12.2	12.6	10.8	15.0	–	–
HN	39.6	39.2	–	39.2	40.3	40.1	46.3	41.6	–	–

11	12	13	14	15	16	17	18	19	20	21	22	23
20.3	17.9	16.5	17.0	17.5	17.4	18.4	16.2	17.9	20.0	18.9	16.0	16.2
24.5	25.0	27.7	30.3	27.5	23.5	22.9	24.3	25.2	22.2	21.6	22.4	16.6
14.6	18.6	19.4	14.4	15.9	13.2+	13.9	12.3	10.2±	13.2±	13.2±	–	–
34.5	25.9	26.5	20.7	21.6	15.8	11.6	13·4	11.4	11.8±	10.9±	–	–

LN: Anteroposterior length of neural spine along dorsal margin.
HN: Height of neural spine along anterior margin.

Cervic Vertebrae: Anterior four and posterior three cervic vertebrae known from holotype specimen, slightly detached from each other in anterior and posterior portions of clavicle respectively. Anterior three vertebrae rotated 90 degrees from their original direction, higher than long, with much expanded thick epiphysial discs, projected from centrum surface. Fourth and 5th vertebrae longer than high, with much expanded fore and aft discs. Sixth and 7th much higher than long, preserved in contact with scapula, with distinctly expanded fore and aft discs.

Thoracic Vertebrae: In holotype specimen, anterior four of thoracic vertebrae from 8th to 11th preserved obscurely in posterior of scapula and left humerus; 12th shown left lateral side, longer than high with distinctly expanded anterior epiphysial disc, surface of centrum smooth and depressed, neural spine unpreserved; six vertebrae from 13th to 18th jointed with each other, and from 14th to 17th jointed with their corresponding costae, longer than high with curved dorsal and ventral margins, and with expanded fore and aft epiphysial discs; 19th and 20th observed in isolated position respectively.

Lumbar Vertebrae: Among 31 vertebrae of Specimen No. E, anterior eighteen ones referred to lumbar vertebrae as they are situated in anterior of ilium. This is because ischium contacts with anteroventral corner of 18th vertebra.

Second, 5th, 10th and 11th vertebrae jointed with their corresponding costae respectively; vertebrae except for 3rd, 6th, 13th–17th rather longer than high, quadrate in outline with straight dorsal and ventral margins; both anterior and posterior margins slightly concaved forward; neural spines unknown. Largest lumbar vertebra of 15th retains thick anterior and posterior epiphysial plates; antero- and posterodorsal corners project upward. Impressions of diapophysis and parapophysis observed in median ventral surface of 11th–15th vertebrae; subovate, and running oblique to longitudinal line of vertebrae.

Caudal Vertebrae: Posterior 13 vertebrae of Specimen No. E and 23 vertebrae of No. L referred to caudal vertebrae respectively. First caudal vertebra of No. E may be sacral one, as it contacts with ilium at anteroventral corner. In Specimen No. E, 1st and 2nd caudal vertebrae quadrate, longer than high with gently curved margins, neural spines unpreserved; 3rd-7th quadrate, rather longer than high with strongly curved margins, ventral margins concave ventrally, neural spines projected postero-upward, overlapping

with their succeeding one, elongate-quadrate in outline with rather straight distal margins; 10th and 11th quadrate, longer than high, anteroventral corners project distinctly forward.

Anterior ten vertebrae of Specimen No. L quadrate with neural spines projected posteriorly, as in Specimen No. E. Centra of 1st to 6th vertebrae amphicoelous with distinct concavity in antero-posterior cross section; 4th, 5th, 6th, 8th and 10th higher than long as their expansion of anterior epiphysial plates. As observed in 2nd vertebra, an extremely narrow central canal may exist, but obscure. Posterior inner surface of centrum concave posteriorly in 1st and 2nd ones, but convex in 6th. Neural spines of 9th and 10th vertebrae bent more obtusely than anteceding vertebrae. Short dichotomous costae jointed with anteroventral corner of 4th, 5th, 6th and 14th respectively.

Eleventh-sixteenth vertebrae of Specimen No. L carry neural spines projecting antero-upwardly, and overlapping their anteceding ones, distal portions expanded with rather straight distal margins; centra nearly quadrate, higher than long, with straight anterior and posterior margins; ventral margins gently curved, concave ventralward; postero-ventral corners project downward. Neural spines of 17th to 21th vertebrae very short, subquadrate in outline, and project upward. Neural spine of 17th vertebra seems to be bent slightly anteriorly, and of 22nd and 23rd unpreserved.

Costae: Left 23 costae of holotype specimen slender, long, narrow and gently curved, although most eminently curved in proximal portions of one seventh of total length. Three costae of 16th, 17th and 18th well preserved at their proximal ends, twisted and jointed with anteroventral corner of their corresponded vertebrae. Costa gently broadening distally, and distal margin straight. About 14 right costae also preserved behind proximal portion of left costae in holotype specimen.

Specimen No. G retains 15 right costae, with rather well preserved proximal portions; articulation of costae may not be single but double; anterior and posterior surfaces divided by a sharp longitudinal crest; dichotomous branching of proximal end rather obsolete; head for diapophysis longer than for parapophysis, which is very short and indistinct.

Specimens of Nos. K_2 and F retain costae, although most of them poorly preserved.

Dimensions:

Holotype specimen (Left)

(in mm)	1	2	3	4	5	6	7	8	9	10	11
L	46.6	145.6	153.6	148.2	191.9±	178.7	150.0±	195.4	200.0±	213.5	232.0
Pw	7.8	6.9±	7.3	7.1	–	5.4	–	–	–	7.0	5.2±
Dw	5.2±	5.5±	7.5±	7.8	5.9	6.6	3.5±	4.4±	5.8	7.6	7.0±

12	13	14	15	16	17	18	19	20	21	22
213.3	223.7	245.5	248.5	60.5+	136.2+	264.4±	67.0+	218.6±	73.4+	40.7+
6.5	6.2	6.4	7.4	6.1±	5.7±	5.6	4.6+	4.9±	4.3±	5.0±
6.8	7.7	7.9	8.2	5.9+	7.5	–	7.5±	7.5	–	–

L: Longitudinal length along anterior surface.
Pw: Width of proximal end as preserved.
Dw: Width of distal end.

Abdominal Costae: Numerous abdominal costae preserved in Specimen Nos. K_1 (holotype) and K_2. In holotype specimen, more than 55 bones of median series preserved in original position showing their ventral side, and jointed with two lateral series of abdominal costae. Bone of median series trifurcated with short and straight longitudinal spine, projects anteroventralward, and two lateral pinnate bones run straight posterodorsalward, connected with each other at an angle of about 130 degrees. Pinnate bone of lateral series of 25th abdominal costa 70.4 mm long, splitted, slender, narrow, straight and closely jointed with lateral pinnate bone of median series.

Caudal Costae: Three small trifurcated bones in cross section observed near 21st to 23rd caudal vertebrae of Specimen No. L (Plate 5). They may be caudal costae jointed with anteroventral corner of caudal vertebrae. It consists of two relatively long spinate bones, connected at an angle of 30 degrees, about 21.7 mm long in longest one. Fourth, 5th, 6th and 14th caudal vertebrae of Specimen No. L represented by a short, platy, thin caudal costa with rather straight distal margin.

Pectoral Girdle and Fore Limb:

Clavicle and Interclavicle: Right and left clavicles and interclavicle preserved in holotype specimen. Proximal part of left clavicle jointed with interclavicle.

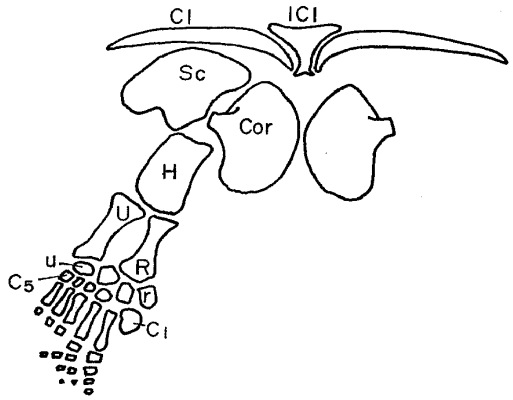

Fig. 11. Pectoral girdle and right fore limb.
C_{1-5}: First to fifth carpal bones, Cl: Clavicle, Cor: Coracoid, H: Humerus, Icl: Interclavicle, R: Radius, r: Radiale, Sc: Scapula, U: Ulna, u: Ulnare

Interclavicle spatulated and expanded distally with rather straight distal margin, 32.4 mm in length; both lateral margin gently curved, proximal corner distinctly constricted; surface ornamented by numerous radial striae converged to median proximal point, 24.9 mm long along median longitudinal line.

Right clavicle strongly curved, convex outward, thick and stout, 54.0 mm long between both ends. Left clavicle curved gently, thickened at middle portion and tapering distally, convex margin of proximal portion closely contacts with curved lateral margin of interclavicle, 95.4 mm in full length.

Scapula and Coracoid: Both right and left scapulae and coracoids preserved in holotype specimen.

Scapula slightly smaller than coracoid, spatulate and semicircular in outline with long and distinctly curved distal margin which contacts with clavicle; outer margin undulated, concave outward, and extero-proximal corner projected proximally and contact with head of humerus; proximal margin rather short and straight; inner margin feebly concave inward. Left scapula of holotype specimen 65.2 mm in maximum transverse width, 38.4 mm in maximum longitudinal length, and 18.8 mm wide and 7.5 mm long in proximal shaft.

Coracoid subtrigonal in outline with curved and long distal margin; outer margin straight; inner margin eminently concave inward.

Humerus: Both right and left humeri preserved in holotype specimen, Humerus subquadrate, slightly curved with almost straight and long inner margin; proximal and distal margins relatively short and weakly curved.

Ulna and Radius: Right and left ulnae, and right radius preserved in holotype specimen. Specimen No. K_2 also retains right ulna and radius.

Ulna elongate quadrate with expanded proximal and distal extremities; proximal margin longer than distal; inner lateral margin tolerably curved. Radius elongate quadrate with expanded extremities of proximal and distal, as ulna in outline; proximal margin straight; distal margin much larger than proximal, and strongly curved.

Ulnare and Radiale: In holotype specimen, right ulnare and radiale well preserved.

Inner ulnare subquadrate or nearly spatulate in outline; distal margin longest and gently curved, while proximal, inner and outer margins relatively short and almost straight. Outer ulnare smaller than inner ulnare, subquadrate, wider than long; distal and inner margins curved slightly, while proximal and outer margins almost straight. Inner radiale large, subquadrate broader than long, and with gently curved inner-, almost straight outer-, and slightly curved distal margins. Inner margin of inner radiale corresponds with extension line of inner margin of radius.

Outer radiale smaller than inner one, subpentagonal, wider than long in lateral direction, and with relatively long and gently curved distal margin.

Two radiales and inner ulnare jointed with distal margin of radius.

Dimensions:

(in mm)	Ulna	Radius	Ulnare		Radiale	
			Inner	Outer	Inner	Outer
Maximum length	36.4	36.2	11.5	6.9	13.0	10.5
Maximum width	20.6	22.7	14.9	11.5	11.3	11.2

Carpus: Five right carpal bones preserved in holotype specimen.

First carpus situated just below outer radiale, larger than outer radiale, subcircular, and with distinctly curved inner margin.

Second carpus preserved just below inner ulnare, suboval, longer than wid in lateral direction, with gently curved distal margin.

From 3rd to 5th carpi located below outer ulnare, small; 3rd carpus subquadrate wider than long in lateral direction, and with rather straight inner and outer margins; 4th obscure; 5th subpentagonal, longer than wide in lateral direction, and with much curved proximal margin.

Dimensions:

(in mm)	1	2	3	4	5
Maximum length	12.0±	6.1	6.2	5.1	5.7
Maximum width	12.0±	9.1	5.3	6.1	6.4

Metacarpus: Five right metacarpi preserved in holotype specimen. Two right and four left metacarpi also observed in Specimen Nos. K_2 and J respectively.

Metacarpus relatively small, columnar; shaft rather straight with expanded proximal extremity; 1st metacarpus has eminently curved outer margin and straight inner margin; from 2nd to 4th show distinctly curved inner margins.

Dimensions of metacarpus in holotype specimen:

(in mm)	1	2	3	4	5
Length of shaft	8.2+	8.7+	5.8+	5.3+	13.4±
Max. width of proximal end	5.5	5.5	5.7	5.8	5.5±

Phalanges: Fourteen phalanges of 1st to 4th digits of holotype specimen preserved. Four phalanges arranged for each digit of 1st to 3rd.

Phalanges of 1st and 2nd digits distinctly wider than long, quadrate, with both straight or slightly curved proximal and distal margins; four phalanges of 2rd digit longer than wide, quadrate; outer margins of proximal phalange of 1st and 3rd digits curved distinctly; distal phalanges of 1st and 2nd digits very small, wider than long, and almost trigonal in 2nd digit. Fourth digit retains only middle and distal phalanges, and latter broader than long.

Dimensions:

Digit (in mm)		Proximal	Upper middle	Lower middle	Distal
1st	Longitudinal length	6.1	3.8	2.5	1.5
	Maximum width	9.7	6.9	4.5	3.8
2nd	Longitudinal length	6.7	5.0	3.0	1.6
	Maximum width	7.8	5.2	5.4	4.0
3rd	Longitudinal length	6.0	4.0	3.2	3.8
	Maximum width	5.7	3.1	3.6	3.7
4th	Longitudinal length	—	3.6	—	1.7
	Maximum width	—	2.9	—	3.1

Pelvic Girdle and Aft Limb: Pelvic girdle and aft limbs of both sides preserved imperfectly in Specimen No. E.

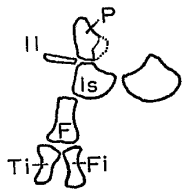

Fig. 12. Pervic girdle and right aft limb. F: Femur, Fi: Fibula, Il: Ilium, Is: Ischium, P: Pubis, Ti: Tibia

Pelvis small, right pelvis jointed with vertebrae, but left one separated. Right ilium small, slender, columnar; shaft gently curved and 21 mm in length. End of right ilium attached with posterior end of 18th vertebra. Right ischium much larger than ilium, subquadrate and expanded distally; posterior margin curved distinctly; distal margin gently curved and broken slightly; 29.7 mm in maximum length, and 17 mm in maximum width. Size of ischium corresponded generally to that of vertebra. Right pubis larger than ischium, spatulate with longest much curved distal, much curved posterior, almost straight proximal and anterior margins; 27 mm in maximum length and 32.7 mm in maximum width. Right femur elongate quadrate with expanded distal end; posterior margin distinctly curved; anterior and distal margins slightly curved; 34.3 mm in length and 24 mm in maximum width.

Left pubis, femur, tibia and fibula separated with each other, and scattered in Specimen No. E. Left femur ill-preserved. Left tibia elongate quadrate with much expanded proximal end, and gently curved posterior margin; shaft 29.7 mm in length, 18.3 mm in maximum width. Left fibula also elongate quadrate or columnar with expanded proximal margin; shaft 34 mm in length and 14.7 mm in maximum width.

Remarks: – From the skeletal nature, the present form is related mostly to *Grippia longirostris* Wiman (1928), described from the Lower to Middle Triassic in Spitzbergen. It was recorded from a horizon between the Lower Pisces zone and the Lower Reptile zone in

the Agradh Range and Mt. Milne Edwards near Sassental. The horizon corresponds to a boundary between the Lower and Middle Triassic.

According to detailed description and illustration of Wiman (1933), pectoral girdle and limb of this species bear a resemblance to those of *G. longirostris*. At least, the scapula and coracoid differ little in outline. However, proximal portions of scapula and coracoid are thicker in the present species than those of *Grippia*. Humerus of *Grippia* shows more eminently curved shaft and exterior margin. Ulna and radius of *G. longirostris* have some resemblance to those of this species, but seem to be relatively shorter, stouter and wider than the latter. Proximal margin of ulna is more strongly curved in *G. longirostris* than the present form. Ulnare, radiale and carpus of both species also resemble each other. Skull of the present form may be like that of *G. longirostris* in general outline with a relatively large orbit and vaulted cranium, etc.

The nature of dentary and teeth of this species are quite different in the general character from the later ichthyosaurus, in possession of independent single alveoli of teeth, no basal enamel folding and no cementum. In Jurassic and Cretaceous forms, the teeth are crowded together in deep alveoli, that run lengthwise along the jaw. Furthermore, the basal tooth wall is intensively radially folded, and the tooth base is surrounded by a coat of cementum (Payer, 1968). As discussed above, the skeletal nature of the present form has some resemblances to *G. longirostris*, however, the tooth form and structure differ from *Grippia*, which has relatively short, semispherical teeth and no distinct longitudinal striations. The radiographs of the present species show some relationships to dentary of "*Mixosaurus*" *schistibituminosi* Besmer (1947) from the Triassic of the Monte San Giorgio, Tessin, Switzerland. However, it is stated that the former possesses no or only a slight folding of the basal portion of the tooth wall and virtually no cementum, and the latter shows considerable radial folding and a notable amount of cementum (Peyer, 1968). Though it is not ascertained whether the cementum is present or not, the present form differs from the specimens of Tessin in having more acutely pointed, smaller and slender teeth. Among the Triassic forms, the tooth structure of the present species has a high similarity with *Pessosaurus* Wiman (1910) (=*Ekbainacanthus* Yakovlev 1902) (Huene, 1956), which has pointed teeth with strong enamel folding, described from the Middle Triassic Upper Reptile zone in Spitzbergen. However, the pectoral limbs were quite different from each other.

Pessoptryx nisseri Wiman (1910), described from the Middle Triassic Upper Reptile zone of Spitzbergen is clearly distinguished from this species by relatively shorter and wider humerus, ulna and radius. In the same characteristics, the present form is easily distinguishable from *Cymbospondylus petrinus* Leidy (1868) described from the Middle Triassic formation of the West Humboldt Range, Nevada, *Mixosaurus cornalianus* (Bassani), 1886 and *Merriamia zitteli* (Merriam), 1903 from the Upper Triassic *Trachyceras* Bed in Shasta County, California, and *Californosaurus perrini* (Merriam), 1905 from the Upper Triassic formations in California. In the best of Merriam (1908), these Late Triassic species are more specialized in pectoral limb than the present new form. The pectoral limbs of *Pachygonosaurus* Huene (1951) described from the Upper Muschelkalk of Oberschlesien, and *Blezingeria* Huene (1951) from the Upper Muschelkalk of Crailsheim, Württemberg are far from exact comparison for the present writers, but they may be related to the Late Triassic forms.

At any rate it should be kept in mind that the present species belong to the most primitive type of Ichthyosauria in the world from the view point of specialization of pectoral limb.

The generic name is derived from the Utatsu-cho (Town), from where the present

type specimens were collected. The present species is named in honor of the late Dr. Kotora Hatai, Professor Emeritus of Tohoku University in recognition of his paleontological work.

Repository:–

Holotype: Specimen No. K_1; IGPS* coll. cat. no. 95941 a, b.

Paratypes: Specimen No. K_2; IGPS coll. cat. no. 95942 a, b.

Specimen No. E; IGPS coll. cat. no. 95943.

Specimen No. L; IGPS coll. cat. no. 95944.

Other Referred Specimens:

Specimen No. F; Educational Comittee of Utatsu-cho, Miyagi Prefecture.

No. G; *Ibid.*, designated to the Natural Monument of Japan.

No. I; K.U.J.M.** Reg. No. 93001.

No. J; K.U.J.M., Reg. No. 93002.

Nos. M, N and Q; G.I.Y.N.U.*** Reg. Nos. M106–M108.

Nos. O and P; IGPS coll. cat. nos. 95945, 95946.

Horizon and Locality: – The present new species occurs from the middle and upper parts of the Osawa Formation of the Inai Group, of which horizons are decided to the *Subcolumbites* and the *Arnautoceratites* zones by Bando and Shimoyama (1974), correlated to the Late Scythian Columbitan – Prohungaritan of Spath (1930). Ten specimens, including the type specimens, were collected from the upper part of the Osawa Formation at Tatezaki, Utatsu-cho, Motoyoshi-gun, Miyagi Prefecture. Three specimens are from the upper part of the Osawa Formation at Osawa, Motoyoshi-cho, Motoyoshi-gun, Miyagi Prefecture. Besides described specimens, many fragmental specimens of this species are collected from the Osawa Formation at Onagawa, Onagawa-cho, Oshika-gun, east of Okatsu, Okatsu-cho, Mono-gun, at Yanaizu, Tsuyama-cho, Tome-gun, and at Hazawa, Toyoma-cho, Tome-gun, all of Miyagi Prefecture.

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* Abbreviation for the Institute of Geology and Paleontology, Tohoku University, Sendai, Japan.

** For Department of Geology and Mineralogy, Kyoto University, Kyoto, Japan.

*** For Geological Institute, Yokohama National University, Yokohama, Japan.

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Plate 1

Utatsusaurus hataii Shikama, Kamei and Murata, gen. et sp. nov.

Ventral side of skull, left side of vertebrate column, dorsal side of right and left fore limbs of holotype, Specimen No. K_1, IGPS coll. cat. no. 95941 a, × 0.3. From the upper part of the Osawa Formation at Tatezaki, Utatsu-cho, Motoyoshi-gun, Miyagi Prefecture. Late Scythian *Arnautoceltites* Zone.

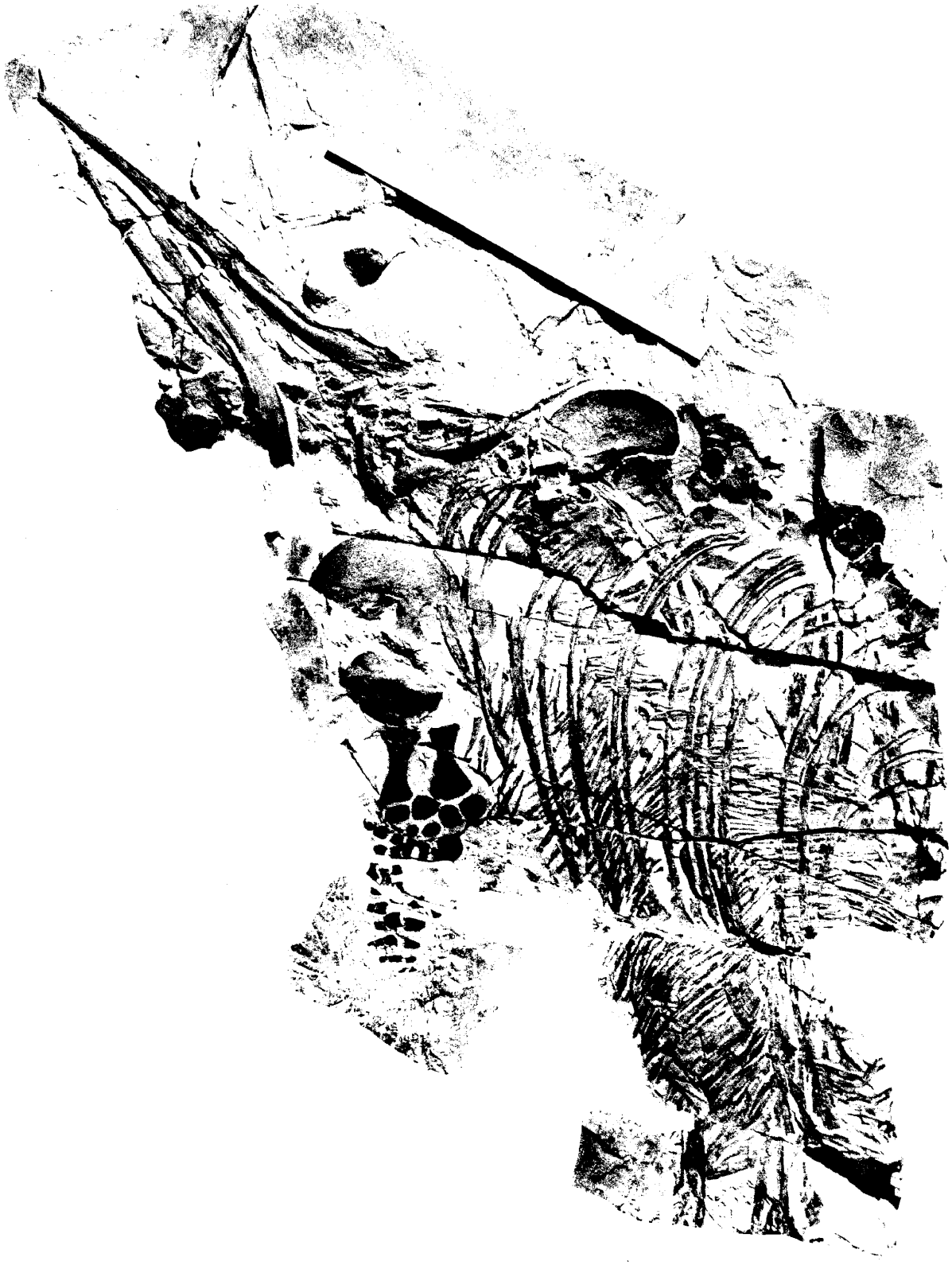

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Plate 2

Utatsusaurus hataii Shikama, Kamei and Murata, gen. et sp. nov.

External mold of the holotype, Specimen No. K_1, IGPS coll. cat. no. 95941 b, × 0.3.

Plate 3

Utatsusaurus hataii Shikama, Kamei and Murata, gen. et sp. nov.

Fig. 1. External mold of a paratype, Specimen No. K_2, IGPS coll. cat. no. 95942 b, × 0.3.
Fig. 2. Dorsal side of skull of Specimen No. K_2, represented with frontal, postorbital, quadratojugal, supratemporal and right orbit with sclerotic ring, × 0.3.
Fig. 3. Ventral side of skull and lower jaw, left side of costae in thoracic region and dorsal side of right fore limb of Specimen No. K_2, IGPS coll. cat. no. 95942 a, × 0.3.
From the upperpart of the Osawa Formation at Tatezaki, Utatsu-cho, Motoyoshi-gun, Miyagi Prefecture. Late Scythian *Arnautoceltites* Zone.

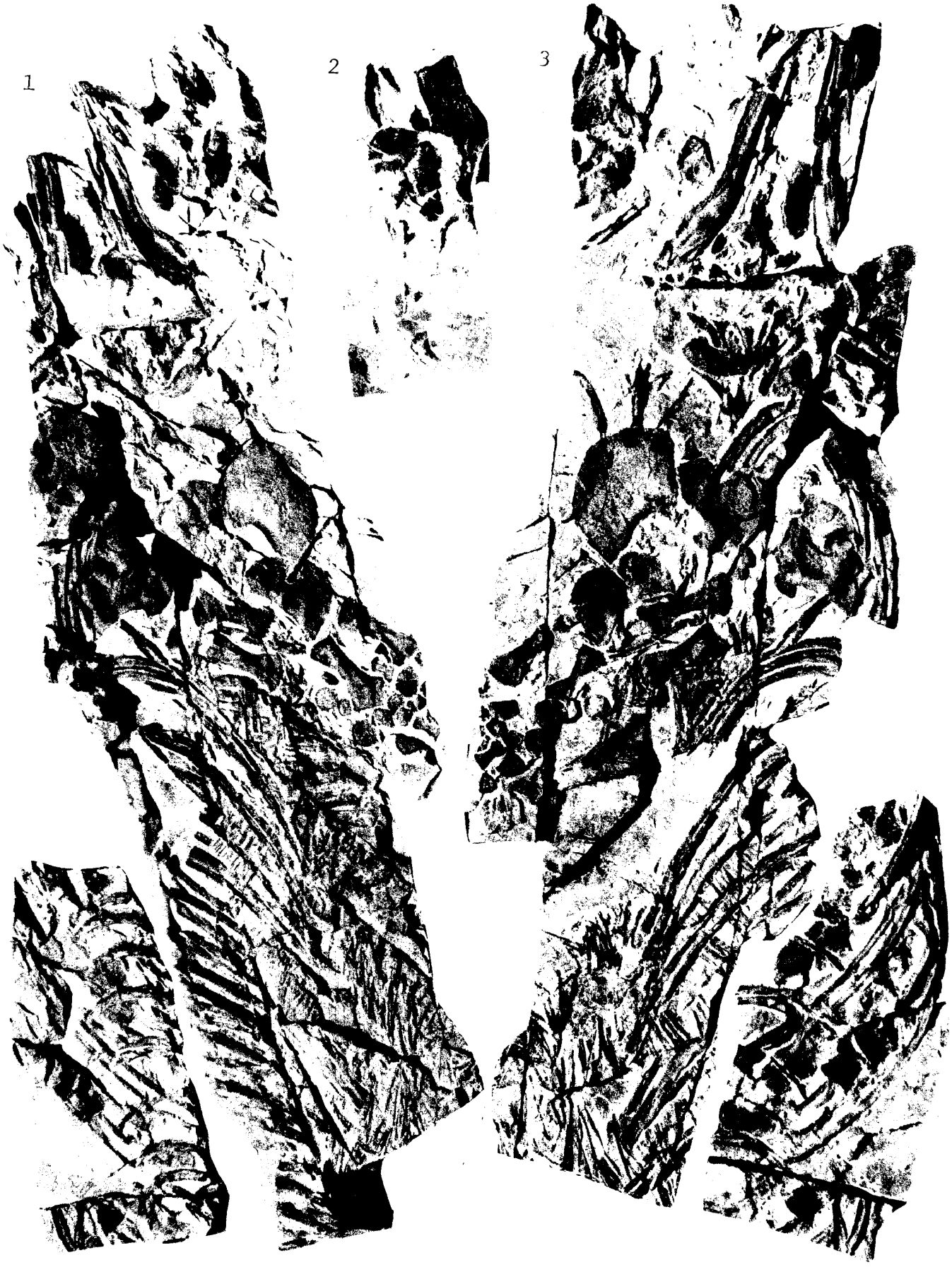

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Plate 4

Utatsusaurus hataii Shikama, Kamei and Murata, gen. et sp. nov.

Right side of posterior vertebrate column, detached ilium, ischium, pubis, femur, tibia and fibla (both sides) of a paratype, Specimen No. E, IGPS coll. cat. no. 95943, × 0.2. From the upper part of the Osawa Formation at Tatezaki, Utatsu-cho, Motoyoshi-gun, Miyagi Prefecture. Late Scythian *Arnautoceltites* Zone.

Plate 5

Utatsusaurus hataii Shikama, Kamei and Murata, gen. et sp. nov.

Left side of caudal vertebrate column of a paratype, Specimen No. L, IGPS coll. cat. no. 95944, × 0.45. From the middle part of the Osawa Formation at Tatezaki, Utatsu-cho, Motoyoshi-gun, Miyagi Prefecture. Late Scythian *Subcolumbites* Zone.

K. Kumagai and S. Otomo Photo

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Plate 6

Utatsusaurus hataii Shikama, Kamei and Murata, gen. et sp. nov.

A portion of anterior vertebrate column (right side) jointed with costae of Specimen No. G, × 0.42. From the upper part of the Osawa Formation at Tatezaki, Utatsu-cho, Motoyoshi-gun, Miyagi Prefecture. Late Scythian *Subcolumbites* Zone.

Plate 7

Utatsusaurus hataii Sikama, Kamei and Murata, gen. et sp. nov.

Fig. 1. Right and left lower jaws (left side), left side of vertebrate column, detached costae, portion of right and left fore limbs of right and left coracoid, scapula, left humerus, ulna, radius, carpal and metacarpal bones of Specimen No. J, K.U.J.M. Reg. No. 93002, × 0.3. From the upper part of the Osawa Formation at Tatezaki, Utatsu-cho, Motoyoshi-gun, Miyagi Prefecture. Late Scythian *Subcolumbites* Zone.

Fig. 2. External mold of the same specimen as fig. 1.

Fig. 3. Orbital region of skull with jugal, lacrymal, frontal and postorbital of Specimen No. Q, G.I.Y.N.U. Reg. No. M108, × 0.5. From the upper part of the Osawa Formation at Osawa, Motoyoshi-cho, Motoyoshi-gun, Miyagi Prefecture. Late Scythian *Arnatoceltites* Zone.

Fig. 4. A caudal vertebra, Specimen No. P, IGPS coll. cat. no. 95946, × 0.5. From the upper part of the Osawa Formation at Osawa, Motoyoshi-cho, Motoyoshi-gun, Miyagi Prefecture. Late Scythian *Arnatoceltites* Zone.

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Plate 8

Utatsusaurus hataii Shikama, Kamei and Murata, gen. et sp. nov.

Fig. 1. Right side of neural spines of vertebrae of Specimen No. N, G.I.Y.N.U. Reg. No. M107, × 0.5. From the middle part of the Osawa Formation at Tatezaki, Utatsu-cho, Motoyoshi-gun, Miyagi Prefecture. Late Scythian *Subcolumbites* Zone.

Fig. 2. External mold of the same specimen as fig. 1.

Fig. 3. A right costa and right and left humeri of Specimen No. 0, IGPS coll. cat. no. 95945, × 0.5. From the upper part of the Osawa Formation at Osawa, Motoyoshi-cho, Motoyoshi-gun, Miyagi Prefecture. Late Scythian *Arnatoceltites* Zone.

Fig. 4. Left side of a portion of vertebrate column, detached costae and a portion of ventral costae of Specimen No. F, × 0.3. From the upper part of the Osawa Formation at Tatezaki, Utatsu-cho, Motoyoshi-gun, Miyagi Prefecture. Late Scythian *Arnatoceltites* Zone.

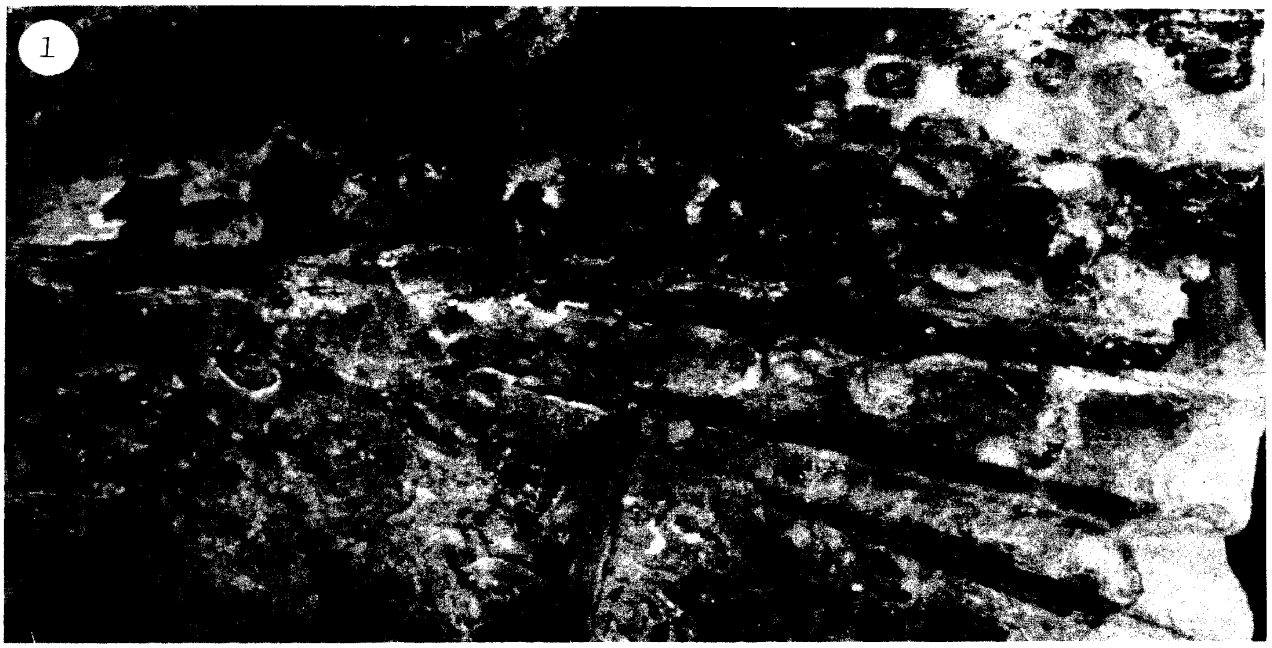
Plate 9

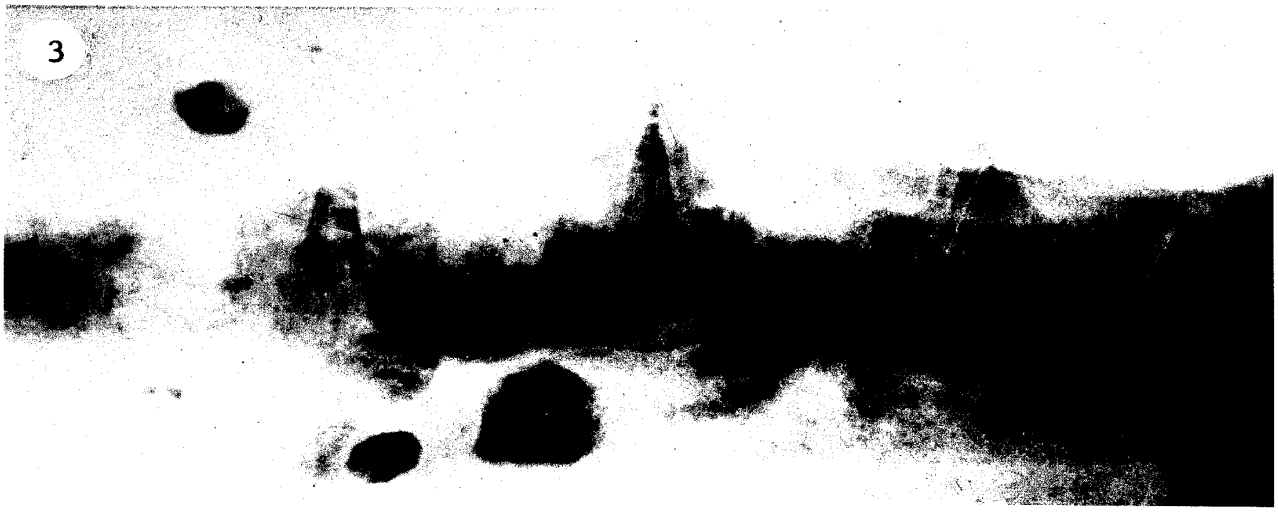
Utatsusaurus hataii Shikama, Kamei and Murata, gen. et sp. nov.

Fig. 1. External mold of a fragmental dentary bone of Specimen No. I, K.U.J.M. Reg. No. 93001, × 2.

Fig. 2. Teeth implanted on the dentary of Specimen No. I, showing radial folding on the surface of the tooth, × 4.

Fig. 3. Radiograph of the tooth row attached on the dentary of the same specimen as fig. 2, × 4. From the upper part of the Osawa Formation at Tatezaki, Utatsu-cho, Motoyoshi-gun, Miyagi Prefecture. Late Scythian *Subcolumbites* Zone.





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