

A Middle Devonian Gastropod Faunule from the Nakazato Formation of Kitakami, Northeast Japan

By

Tomoki KASE¹ and Tamio NISHIDA²

¹ Department of Geology, National Science Museum, Tokyo

² Institute of Earth Sciences, Faculty of Education, Saga University, Saga

Abstract The Nakazato Formation, the only fossiliferous Middle Devonian unit known in Japan, yields diverse shallow marine invertebrate fossils. Eight gastropod species from a thin fine-grained sandstone bed at one locality, represent the first Middle Devonian gastropods recorded from Japan. One new genus, *Fujispira*, probably of the Omphalotrochidae, five new species, *Tropidodiscus* (*Tropidodiscus*) *nakazatensis*, *Orecoxia kobayashii*, *Fujispira japonica*, *Ulrichospira kanekoi* and *Euryzone onoi*, and three unnamed species, *Bellerophon* (*Bellerophon*) sp., *Retispira* sp. and *Murchisonia* (*Murchisonia*) sp., are described in this report. Although faunal affinity of the Nakazato biota is still poorly known, this gastropod faunule provides additional information for understanding the Middle Devonian biota of Japan.

Introduction

The Nakazato Formation is the middle unit of the Devonian that crops out in the Hikoroichi District at the northeastern end of the Southern Kitakami massif, Northeast Japan (see figs. 2b-1 and 2b-2 in MINATO *et al.*, 1979). It is the only formation cropping out in Japan that has been definitely dated as Middle Devonian by paleontological evidence. This formation consists of volcanic and shallow marine clastic sediments, measures about 1420 meters in thickness, and has been divided into four members: N1, N2, N3 and N4 in upward sequence (MINATO, KATO and HAGA in MINATO *et al.*, 1979). Fossils are sparse in this formation, but heretofore described or illustrated taxa include trilobites, brachiopods, corals and others (SUGIYAMA and OKANO, 1941; SUGIYAMA, 1942, OKUBO, 1950, 1951, 1956; MINATO and KATO, 1977; KATO in MINATO *et al.*, 1979; COPPER *et al.*, 1982; KANEKO, 1984; 1985). These fossils are most concentrated in the N3 Member, and at two localities in Kuronborasawa, a small tributary of the Ohmorizawa Valley, and in a small tributary of the Higuchizawa Valley (Loc. A and Loc. B of KATO in MINATO *et al.*, 1979).

During his study of the trilobites in the small tributary of the Higuchizawa (National Science Museum Paleontological Collection Locality No. 6-53-1), Mr. KANEKO found a sandstone bed of the N3 Member of the Nakazato Formation that yields ubiquitous gastropods as well as a few bivalves. This locality is about 20 meters downstream from

and stratigraphically about 15 meters below the trilobite-bearing locality, from which KANEKO (1984, 1985) collected a number of trilobites and described three trilobite species. He confirmed that this locality is the same as Loc. B mentioned above and suggested that the stratigraphic level of both Loc. A and Loc. B may be synchronous and dated as Eifelian because from both localities he recognized *Thysanopeltella paucispinosa* (OKUBO) and *Dechenella (D.) minima* (OKUBO). This age assignment is conformable with that of COPPER *et al.* (1982), who redescribed an atrypoid brachiopod from Loc. A as *Atrypa (Planatrypa) japonica* SUGIYAMA of middle or late Eifelian age.

Very little is known about Devonian gastropods from Japan. Only one species has been described from Lower Devonian of Fukuji, central Japan (KASE, NISHIDA and NIHO, 1985). Gastropoda are less dominant fossils in the N3 Member of the Nakazato Formation, OKUBO (1950) listed *Murchisonia* sp. and *Pleurotomaria* sp. from Loc. A. Our collection from Loc. NSM-PCL6-53-1 contains ubiquitous molds of gastropods. Silicon rubber casts from these molds enable us to examine this gastropod faunule that consists of eight species, among which we described five as new species, and one as a new genus probably of the Omphalotrochidae.

The fossils described in this paper were collected from massive fine-grained sandstone with thin intercalations of black shale. The thickness of this sandstone unit has not been measured because the outcrop is small. In any case, the fossils are concentrated in a sandstone bed that is two meters thick. Besides the gastropods, this sandstone bed also yields several species of bivalves. These bivalves are quite often articulated and we have discriminated at least two species: *Modiomorpha* sp. and *Paracyclas?* sp. In addition, an absence of brachiopod is one characteristic of this assemblage.

This is the first description of Middle Devonian gastropods from Japan, and provides additional information for understanding the little known characteristics of Japanese Middle Devonian faunas.

In our systematic paleontology section, we are ignored taxonomic problems of bellerophontiform and euomphalacean molluscs, and are adopting the taxonomy as presented by KNIGHT, BATTEN and YOCHELSON (1960). All specimens used in this paper are housed in the collections of the Section of Invertebrate Paleontology, Department of Geology, National Science Museum, Tokyo.

Systematic Paleontology

Superfamily Bellerophontacea M'COY, 1851

Family Bellerophontidae M'COY, 1851

Subfamily Tropidodiscinae KNIGHT, 1956

Genus **Tropidodiscus** MEEK and WORTHEN, 1866

Subgenus *s. str.*

Tropidodiscus (Tropidodiscus) nakazatensis sp. nov.

(Figs. 1A-G)

Diagnosis: A small species of *Tropidodiscus (T.)* with narrowly doubly phanero-

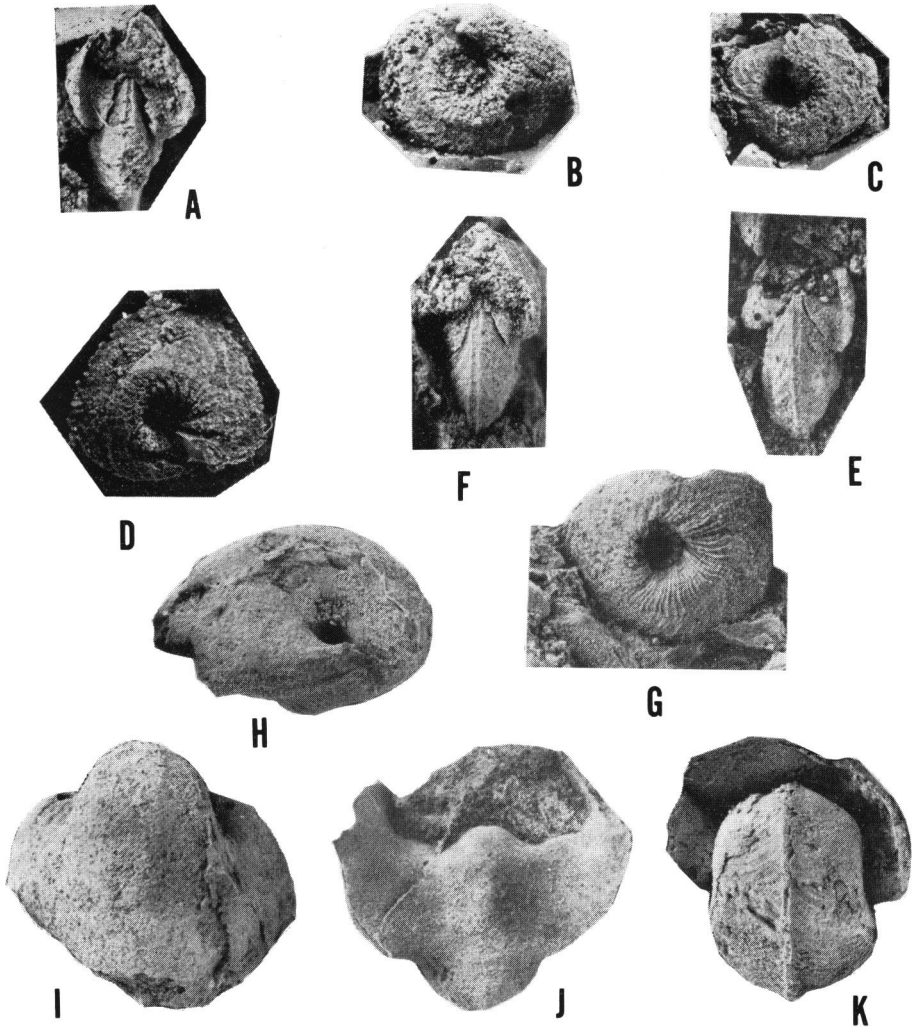


Fig. 1. A–G, *Tropidodiscus (Tropidodiscus) nakazatensis* sp. nov., A, B, apertural and side views of a paratype, NSM-PM15308, maximum length, 4.3 mm, width, 2.8 mm, $\times 6$; C, side view of a paratype, NSM-PM15310, maximum length, 3.4 mm, $\times 6$; D, side view of a paratype, NSM-PM15311, maximum length, 4.5 mm, $\times 6$; E, apertural view of a paratype, NSM-PM15309, maximum length, 4.8 mm \pm , width, 2.6 mm, $\times 6$; F, G, apertural and side views of the holotype, NSM-PM15312, maximum length, 4.8 mm, width, 2.6 mm, $\times 6$. H–J, *Retispira* sp., side, dorsal and apertural views of NSM-PM15313, maximum length, 14.1 mm+, thickness, 10.5 mm, width, 16.0 mm+, $\times 2.5$. K, *Bellerophon (Bellerophon)* sp., apertural view of NSM-PM15314, maximum length, 13.7 mm+, width, 13.0 mm+, $\times 2.5$. All specimens are silicon-rubber casts.

mphalous umbilici and a wide shell profile. Circumbilical margins swollen. Dorsal margin slightly hastate, with a narrow and concave selenizone that is separated from lateral portions of whorl by sharp threads. Ornamentation consisting of fine, sigmoidal and more or less irregularly spaced transverse costae over the lateral portions of whorl and, in addition, of very fine spiral threads on the circumbilical swellings.

Description: Small, lenticular, narrowly doubly phaneromphalous bellerophontid gastropods with maximum length 1.5 to 2 times greater than wide. Dorsal margin slightly hastate, giving rise to a narrow and concave selenizone that is separated from lateral sides of whorl by fine sharp threads. Characteristics of the selenizone unknown. Lateral portions of whorl very weakly convex, then abruptly change adaxially to variably inflated circumbilical swellings. Umbilici narrow with overhanging umbilical walls; umbilical sutures well impressed. Aperture tangential to body whorl and subtriangular in outline. Parietal inductura moderately thick. Surface ornamentation somewhat variable, consisting of fine, sigmoidal and more or less irregularly spaced transverse costae over the shell surface; in addition, these costae are crossed by much finer spiral threads on the circumbilical swellings, thence the surface is reticulate in appearance. These costae become abruptly curved posteriorly, then they extend to the selenizone, forming regularly rounded, rursiradiate curvature. In some large specimens, these costae seem to become progressively obsolete on the dorsolateral sides of the body whorl during ontogeny.

Discussion: This species is very commonly found at Loc. PCL6-53-1, but most specimens do not show delicate surface ornamentation because of their very small shell size and the coarse nature of the matrix, in addition to poor preservation of material. The holotype is the best preserved specimen and exhibits the delicate adult surface ornamentation and the characteristic selenizone. The prominence of the circumbilical swellings and the transverse costae is variable to some extent; the holotype has finer transverse costae, but one of the illustrated paratypes (Fig. 1C) has coarser transverse costae, and some large unillustrated specimens show almost smooth shell surfaces.

Tropidodiscus (T.) nakazatensis is distinguished from the many other Devonian species of *Tropidodiscus (T.)* by its small shell size, wide shell profile, narrow umbilici, and by the presence of circumbilical swellings and characteristic surface ornamentation. Among Devonian species, there seems to be no species that could easily be confused with *T. (T.) nakazatensis*. The most similar species is *Tropidodiscus vasculilineatus* LINSLEY, 1968 from the Middle Devonian Anderdon Limestone of Ohio, the United States, which is small in size and has narrow umbilici and a hastate dorsal selenizone. However, the Nakazato species is distinct from *T. vasculilineatus* by having circumbilical swellings, much finer transverse costae and very fine spiral threads on the circumbilical swellings.

The Nakazato species resembles *Tropidodiscus (T.) praegensis* HORNÝ, 1962 from the Lower Devonian of Bohemia, because both species are small and have somewhat similar surface ornamentation on the lateral portions of the whorls. It clearly differs

from *T. (T.) praegensis*, primarily by having circumumbilical swellings and different surface ornamentation. It also resembles *Tropidodiscus (T.) centrifugus* (CHAPMAN, 1916), (TASSELL, 1982) from the Lower Devonian of Victoria and New South Wales, Australia, but differs in having narrower umbilici and different surface ornamentation in addition to the presence of circumumbilical swellings.

Figured specimens: Holotype, NSM-PM15308; Paratypes, NSM-PM15309-15312.

Genus *Bellerophon* MONTFORT, 1808

Subgenus *s. str.*

Bellerophon (Bellerophon) sp.

(Fig. 1K)

Discussion: A silicon cast from the only external mold shows imperfectly the characteristics of the shell. The Nakazato specimen is small for this genus and subglobose. It shows a slightly compressed and narrowly doubly phaneromphalous bellerophonitiform and possesses a gently arched dorsum. Selenizone is strongly convex, narrow and crested. Umbilici are narrow and surrounded by inflated lateral slopes and lateral lips, the latter of which are thin and not so prominently flared. Aperture is incompletely known. The parietal area is coated by a thin callus. Shell surface is ornamented by moderately coarse, sharp transverse costae.

This unnamed species is characterized by having a prominently crested, narrow dorsal selenizone, weak lateral angulations on the whorl and moderately coarse, sharp transverse costae on the shell surface. The Nakazato species appears to have much in common with *Bellerophon stummi* LINSLEY, 1968 from the Middle Devonian Anderdon Limestone of the United States, but differs in its larger shell size, in having angulations on the lateral portions of the whorls, and by coarser transverse costae on the shell surface.

It is similar to *Bellerophon (Bellerophon) vasulites* MONTFORT, 1808, (KNIGHT, 1941, pl. 11, figs. 3a-e), the type species of the genus, from the Middle Devonian of Germany. The shell size of the Nakazato species is about half of that of *B. (B.) vasulites*. Also, the selenizone is more highly elevated and the lateral sides of the whorls are more strongly angular than those of *B. (B.) vasulites*. These facts suggest that the Nakazato species is separable from *B. (B.) vasulites*.

Bellerophon (B.) cresswelli ETHERIDGE, 1891 from the Lower Devonian of Victoria, Australia, has similar shell outline to the Nakazato species, although it is more than two times larger. TASSELL (1976) redescribed *B. (B.) cresswelli* carefully and recognized ontogenetic changes in shell form and surface ornamentation. The general shell outline is particularly similar between the Nakazato and small-sized Victoria specimens, in that the whorl profile is gently arched dorsally and more strongly curved on the sides. TASSELL (1976) clarified that the selenizone of *B. (B.) cresswelli* is bordered by very fine threads. The Nakazato species has coarser transverse costae than *B. (B.) cresswelli*

and a more highly elevated crest-topped narrow selenizone that is not bordered by threads.

Figured specimen: NSM-PM15314.

Subfamily Knightitinae KNIGHT, 1956

Genus *Retispira* KNIGHT, 1945

Retispira sp.

(Fig. 1H-J)

Discussion: One specimen is assigned to an unnamed species of *Retispira*. It is small, doubly narrowly phaneromphalous bellerophontid gastropod, with fairly rapidly expanded aperture. The dorsal selenizone is incompletely represented by a weak and flat-topped elevation, characteristics of which are unknown. The whorl profile is arched dorsally and has weakly convex dorsolateral sides and weak angulations on both sides. Umbilici are moderately wide and deep, and are surrounded by flattened lateral slopes of the whorl and thick lateral lips, the latter of which are flared somewhat backward in the umbilical region. The surface ornamentation is incompletely known, consisting of very fine spiral threads that are crossed by fine transverse growth lines. The aperture is incomplete, but has a thin parietal inductura and a weak spiral ridge on the floor of the inner whorl.

The Nakazato species has much in common with *Retispira*, known from the Devonian to Lower Triassic, in that it is a small, narrowly phaneromphalous bellerophontid gastropod with a more or less flared aperture and reticulated ornamentation. However, the presence of a spiral ridge on the floor of the inner whorl is reminiscent of *Bucanopsis*, a genus that is very similar to *Retispira* but is unknown above Silurian (KNIGHT, BATTEN and YOCHELSON, 1960). *Bucanopsis* differs from *Retispira* in having a spiral ridge on the floor of the inner whorl (KNIGHT, 1945; and others) as well as in having rapidly expanded whorls and a plate-like extension of the parietal lips (BATTEN, 1966). However, the spiral ridge of the Nakazato species is much weaker than that of *Bucanopsis*.

This unnamed species is separable from all the other known Devonian species of *Retispira* by the presence of the weak spiral ridge on the floor of the inner whorl and by having finer reticulated surface ornamentation. *Retispira retifera* (TALENT, 1963), (TASSELL, 1982) from the Lower Devonian of Victoria and New South Wales, Australia is similar to the Nakazato species in general shell outline and shell size, but differs in having much finer surface ornamentation in addition to the presence of the spiral ridge on the floor of the inner whorl. The Nakazato species also differs from *Retispira leda* (HALL, 1861), (ROLLINS, ELDRIDGE and SPILLER, 1971) from the Middle Devonian of New York State, the United States by its small shell size and the presence of the spiral ridge on the floor of the inner whorl.

Figured specimen: NSM-PM15313.

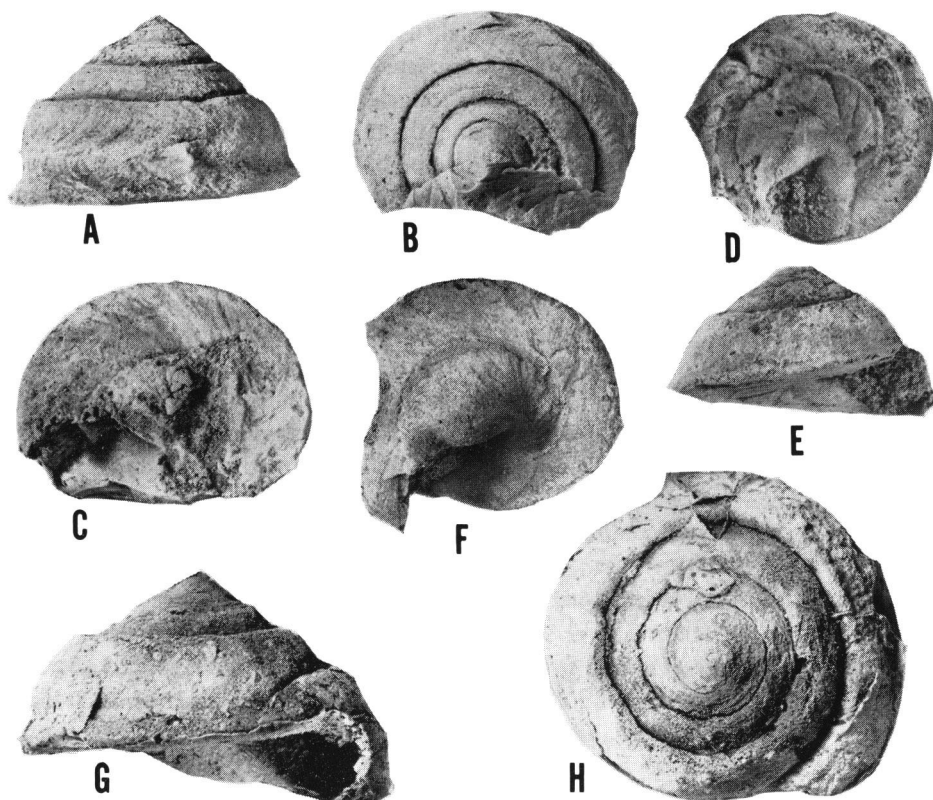


Fig. 2. A–H, *Ore copia kobayashii* n. sp., A–C, back, apical and basal views of the holotype, NSM-PM15315, maximum diameter, 26.5 mm+, height, 17.7 mm, $\times 1.5$; D, E, basal and apertural views of a paratype, NSM-PM15318, maximum diameter, 24.0 mm, height, ca. 15 mm, $\times 1.5$; F, basal view of a paratype, NSM-PM15317, maximum diameter, ca. 26 mm, $\times 1.5$; G, H, apertural and apical views of a paratype, NSM-PM15319, maximum diameter, ca. 36 mm, height, 20.5 mm, $\times 1.5$. All specimens are silicon-rubber casts.

Superfamily Euomphalacea DE KONINCK, 1881

Family Omphalotrochidae KNIGHT, 1945

Genus *Ore copia* KNIGHT, 1945

Ore copia kobayashii sp. nov.

(Fig. 2A–H)

Diagnosis: Large, anomphalous and low conical trochiform species of *Ore copia* with a wide and thick callus pad on the base and a weak spiral swelling slightly below the middle of the upper whorl surface. Growth lines sigmoidal and sinuous slightly below the spiral swelling.

Description: Low conical trochiform and anomphalous gastropods with a mean

pleural angle of about 110° and with height about $3/5$ of shell height. Height of spire about half of total shell height. Protoconch unknown. Sutures distinct and linear in earlier whorls but gradually becoming impressed in later whorls. Spire whorl surface weakly convex as a whole; convexity is strongest just below sutures, then it gradually weakens downward. Body whorl prominently angulated at periphery, with a convex whorl surface similar to those of spire whorls above; at slightly below midwhorl there exists a weak spiral swelling, below which whorl surface is weakly concave. Base flattened. Umbilical area covered by a thick and widely expanded callus pad; width of callus pad occupies a little more than half of base. Aperture subquadrangle in shape; outer and inner lips callused and robust. Whorl surface and base ornamented by only growth lines. Growth line sigmoidal; on upper whorl surface these are opisthocyrt and prosocline above spiral swelling, prominently sinuous just below spiral swelling and steeply prosocline above basal periphery. Growth lines on base prorsiradiate.

Discussion: The holotype and illustrated paratypes show the characteristic shell shape, sinuous growth lines and a callus pad. Unillustrated specimens are mostly poorly preserved, some of which, lacking the callus pad due to erosion, show that the base of this species is not umbilicated. This species possesses a consistently widely expanded callus pad on the base. The presence of the callus pad on the base, the lack of umbilicus, and low conical trochiform shell shape readily separate *O. kobayashii* from all other *Orecoxia* species.

Orecoxia was represented by five species known from Upper Devonian of western North America and the Soviet Union (PEDDER, 1966) and by one species known from Lower Devonian of Australia (TASSELL, 1978). *O. kobayashii* is, therefore, the first record of the genus from the Middle Devonian and from eastern Asia. *O. kobayashii* most resembles *O. mccoyi* (WALCOTT, 1884), (KNIGHT, 1954; PEDDER, 1966) from the lower Upper Devonian of the western United States, but differs in lacking an umbilicus and by its larger shell size, having a widely expanded funicle, and by having a spiral swelling located slightly below the middle of the upper whorl surface. Furthermore, the growth lines in *O. kobayashii* are sinuous slightly below the spiral swelling on the upper whorl surface, but those in *O. mccoyi* are sinuous at periphery.

Etymology: Named for Dr. Teiichi KOBAYASHI, M.J.A., who is conducting the JTAF (Studies on Japanese Trilobites and Associated Fossils).

Figured specimens. Holotype, NSM-PM15315; paratypes, NSM-PM15317-15319.

Family Omphalotrochidae ?

Genus *Fujispira* nov.

Type species: *Fujispira japonica* n. sp.

Diagnosis: Large, phaneromphalous and low conical trochiform gastropod with a carinate periphery. Height is about $3/5$ of maximum diameter. Base flat and has a moderately wide umbilicus. Surface of early whorls rounded and separated by impressed sutures. Body whorl discoidal, with a gently arched upper whorl surface.

Aperture radial and subtriangular in shape with an acute sinus at periphery that projects fairly forward. Growth lines rugose, opisthocline and sinuated slightly below upper angulation on body whorl surface, acutely sinuated at periphery and steeply opisthocline on base. Upper edge of the body whorl bears nodes that are irregularly spaced. Surface smooth except for growth lines.

Discussion: This genus is established with some hesitation because of the poor preservation of the type specimen, and it is assigned to the Omphalotrochidae with query. The only specimen from the Nakazato Formation has characteristics similar to those of some genera of the Omphalotrochidae, but differs from them in having a very low conical trochiform shell shape and an upper labral sinus located slightly below the upper angulation of the body whorl. *Fujispira* is closest in form to *Babylonites*, a Permian genus with five species in North America (YOCHELSON, 1956). Unlike *Fujispira*, all *Babylonites* are smaller in shell size and have a more highly elevated spire, flattened or concave upper whorl surface and a spiral ridge on the lower part of the whorl surface. The upper labral sinus on the outer lip of *Fujispira* is more prominently sinuated than that of *Babylonites* and is located slightly below the upper body whorl angulation. *Fujispira* has a sinus on its forward projection that is also more prominent than in *Babylonites*.

Fujispira differs from *Omphalotrochus* in having a more depressed shell shape, weakly inflated whorl surface, a subtriangular aperture and an upper labral sinus that is located slightly below the upper body whorl angulation. It also differs from *Bassotrochus* TASSELL, 1978, a monotypic genus from the Lower Devonian of Victoria, Australia, by its larger shell size, having an open umbilicus and lack of a peripheral frill.

The new genus is similar to some high-spired species of *Euomphalus* of the Euomphalidae. However, the latter species have an upper labral sinus at the middle of the upper whorl surface and a peripheral lip that does not project so far forward as *Fujispira*.



Fig. 3. *Fujispira japonica* gen. et sp. nov., oblique view of the holotype, NSM-PM15320, maximum diameter, 118.0 mm, height, ca. 40 mm, $\times 1$. The specimen is a silicon-rubber cast.

Etymology: The generic name is derived from the combination of *Fuji* meaning Mt. Fuji and the Latin *spira* meaning coiled or twisted.



Fig. 4. *Fujispira japonica* gen. et sp. nov., back and basal views of the holotype, $\times 1$.

Fujispira japonica n. sp.

(Figs. 3A, 4A–B)

Diagnosis: As for the genus.

Description: Large, phaneromphalous, low conical trochiform gastropod with height about half of maximum shell diameter and height of spire about 3/5 of shell height. Angle in neighborhood of penultimate whorl about 130°. Characteristics of protoconch and early teleoconch whorls unknown. The two preserved spire whorls are roundly convex and separated by impressed sutures. Body whorl fairly discoidal and has a weakly convex and arched upper whorl surface and a carinated periphery. Upper whorl angulated and irregularly noded in later growth stage in corresponding with discoidal nature of whorls. Base flat. Umbilicus moderately wide and has an angulated circumumbilical rim; umbilical whorl surface flat and vertical. Aperture radial and subtriangular in shape; outer lip gently arched, inner lip narrowly rounded and basal lip nearly straight and horizontal. Outer lip and basal lip form an acute sinus at periphery that projects fairly far forward. Growth lines on whorl surface opisthocline with a sinus slightly below upper whorl angulation of adult whorl, following an acute prosocyrte sinus at periphery, then turning to steeply opisthocline and opisthocyrte on base. No ornament except for growth lines.

Discussion: This species is represented by an imperfect external mold, and the silicon rubber case taken from this mold reveals the characteristics of the shell. The shell is weakly deformed laterally, so that the convexity of the whorl surface is variable. The whorl surface of the body whorl near the aperture is fractured by post-depositional deformation, and this part seems to have been originally weakly convex. The surface of the body whorl about one-half volution back from the aperture may indicate original whorl convexity. The spire of this specimen is incomplete and evidently missing several early whorls, but the proportions of two spire whorls and the body whorl suggest that the early whorls may have been elevated slightly and that the shell may have been low conical trochiform in shape.

Figured specimen: Holotype, NSM-PM15320.

Superfamily Pleurotomariacea SWAINSON, 1840

Family Phanerotrematidae KNIGHT, 1956

Genus *Ulrichospira* DONALD, 1905*Ulrichospira kanekoi* sp. nov.

(Fig. 5C–G)

Diagnosis: Very similar to the type species of the genus, but with slightly thicker spiral cords. The two spiral cords delimiting selenizone are located slightly higher than midwhorl. Ornamentation consists of fine transverse costae on lower whorl and base.

Description: Small, anomphalous and highly elevated turbiniform gastropods

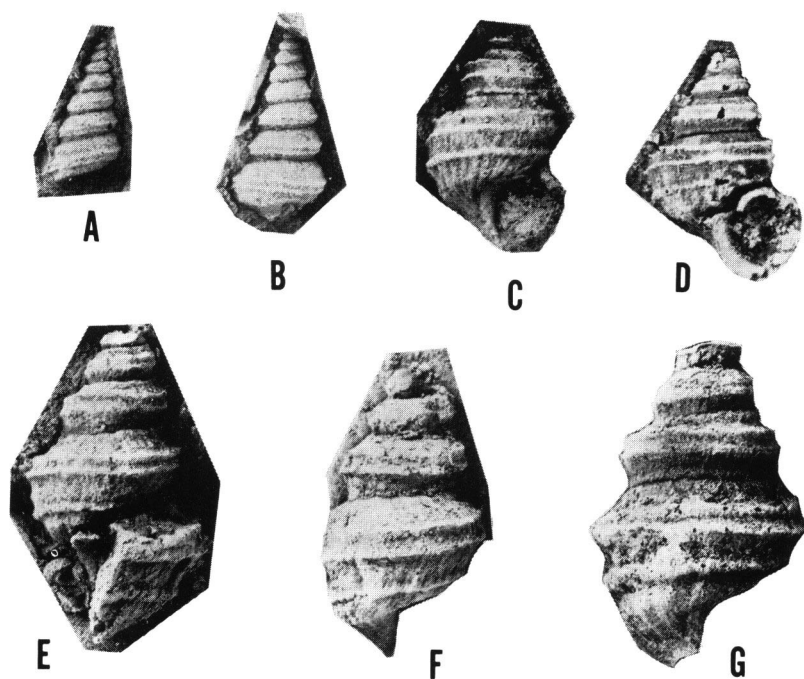


Fig. 5. A, B, *Murchisonia* (*Murchisonia*) sp., A, side view of a specimen, NSM-PM15325, maximum diameter, 8.1 mm, height, 13.5 mm+, $\times 2$; B, side view of a specimen, NSM-PM15326, maximum diameter, 4.7 mm, height, 9.7 mm+, $\times 2.5$. C–G, *Ulrichospira kanekoi* sp. nov., C, apertural view of the holotype, NSM-PM15328, maximum diameter, 6.6 mm+, height, 10.2 mm+, $\times 3$; D, apertural view of a paratype, NSM-PM15331, maximum diameter, 7.1 mm, height, 10.1 mm, $\times 3$; E, side view of a paratype, NSM-PM15329, maximum diameter, 8.5 mm, height, 14.1 mm+, $\times 3$; F, back view of a paratype, NSM-PM15332, maximum diameter, 7.4 mm, height, 13.1 mm+, $\times 3$; G, back view of a paratype, NSM-PM15333, diameter, 10.0 mm, height, 15.1 mm+, $\times 3$.

with a mean pleural angle of about 50° . Height is about 1.6 times greater than width. Spire highly elevated, making up about $2/3$ of total shell height. Protoconch and early whorls unknown. Whorls angularly convex slightly above midwhorl and separated by moderately impressed sutures. On spire whorls a moderately wide and concave selenizone, delimited by two prominent round-topped spiral cords, located slightly above midwhorl. Upper whorl surface below suture weakly concave and slightly overhanging. Body whorl with three spiral cords, the lowest one of which separates outer whorl surface from base. Base obtusely angulated at middle and lacking umbilicus. Aperture subcircular in shape. Outer lip unknown. Inner lip thickened by callus and regularly curved. Basal lip also regularly curved and weakly reflexed. Ornamentation consists of fine transverse costae, which die out at the selenizone.

Discussion: This species is very abundant, although well-preserved specimens are rare. The variation is mainly manifested by the prominence of the transverse costae

and in part by the pleural angle. The holotype and some paratypes (Fig. 5C, E) possess prominent transverse costae, but other paratypes (Fig. 5D, F, G) possess very weak costae on the base.

DONALD (1905) erected *Ulrichospira* based on the monotypic species, *U. similis* DONALD (1905) from the Lower Silurian of England. DONALD's species was described from an incomplete specimen that lacks the apical whorls and anterior end. Because of the poor preservation of the material, DONALD did not clarify characteristics of the aperture. KNIGHT (1942, p. 377), however, reexamined the morphological concept of *U. similis* based upon DONALD's description and illustration, and his concept is expressed by the *Treatise* figure of *U. similis* (KNIGHT, BATTEN and YOCHELSON, 1960, fig. 124–3). The assignment of the Nakazato species to *Ulrichospira* is based on the fact that the shell shape and the position of the selenizone and three spiral cords of *U. kanekoi* are nearly the same as shown in the *Treatise* figure. The difference is only that *U. kanekoi* has slightly thicker spiral cords and a somewhat more highly positioned selenizone than *U. similis*. Furthermore, *U. similis* possesses transverse costae on the upper whorl surface, but in *U. kanekoi* these are restricted on the lower whorl surfaces.

Etymology: This species is named for Mr. Atsushi KANEKO, who discovered this gastropod faunule.

Figured specimens: Holotype, NSM-PM15328; paratypes, NSM-PM15329, 15331–15333.

Family Gosseletinidae WENZ, 1938
Subfamily Coelozoninae KNIGHT, 1956
Genus *Euryzone* KOKEN, 1896
Euryzone onoi sp. nov.

(Fig. 6A–H)

Diagnosis: A species of *Euryzone* with subdiscoidal, nearly planispiral bicarinate whorls. Umbilicus very wide and delimited from outer whorl surface by a wrinkled circumumbilical ridge. Spire depressed to very weakly elevated. Early basal whorls flattened and ornamented by fine prorsiradiate ribs. Slit short and wide, culminating in a slit band slightly below upper whorl carina. Upper whorl surface concave.

Description: Subdiscoidal and nearly planispiral gastropods with a depressed to very weakly elevated spire. Early whorls loosely coiled and angulated above. Sutures impressed. Body whorl bicarinated above and below, both carinae serrated or nodose. Upper whorl surface flattened to concave, with radial, prosocyrct rugose growth lines. Outer whorl surface roundly convex, with a wide and flat selenizone located slightly below upper carina; selenizone delimited by a spiral thread on each side. Growth lines on outer whorl surface between the selenizone and lower carina weakly prosocline and prosocyrct. Umbilicus wide, with flattened to weakly convex basal whorl surfaces, turning toward vertical just before reaching umbilical sutures. Early umbilical whorl surfaces ornamented by fine prorsiradiate ribs, which become gradually broken into

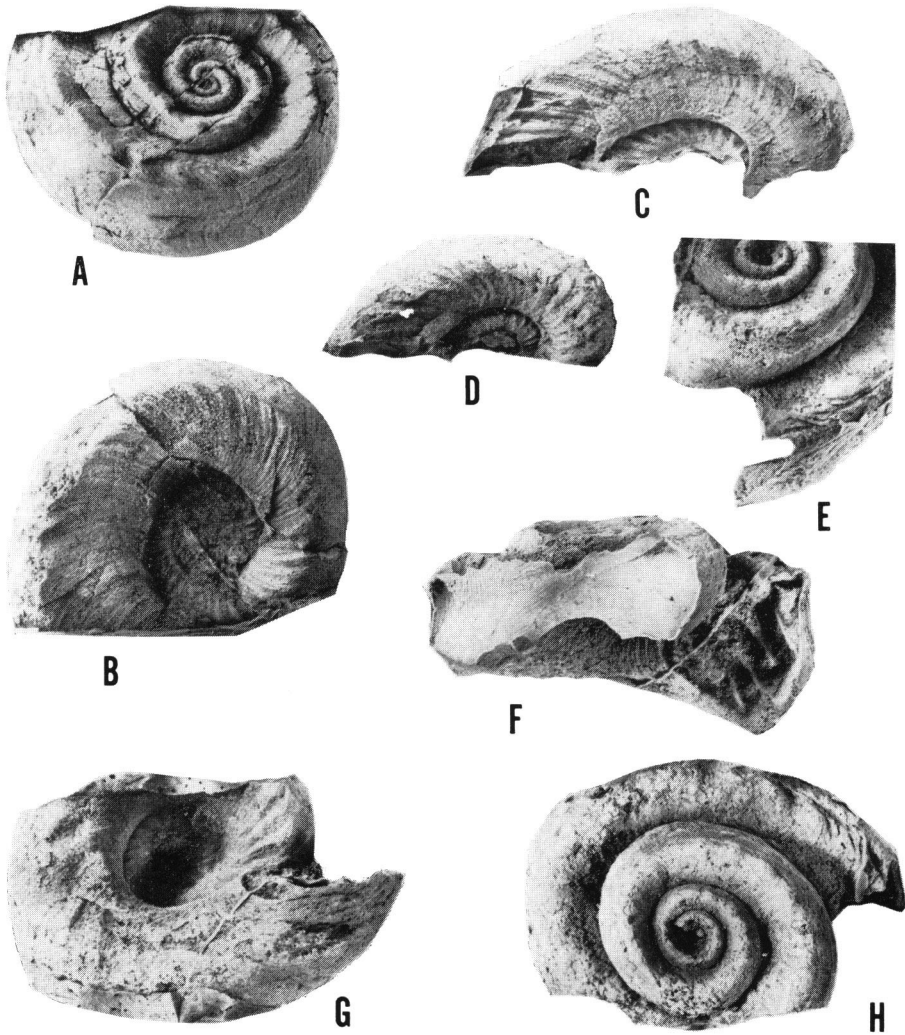


Fig. 6. *Euryzone onoi* sp. nov., A, B, oblique and basal views of the holotype, NSM-PM15321, maximum diameter, 32.5 mm, height, 11.0 mm, $\times 1.5$; C, basal view of a paratype, NSM-PM15323, $\times 1.5$; D, basal view of a paratype, NSM-PM15324, $\times 1.5$; E-H, oblique, apertural, basal and apical views of a paratype, NSM-PM15322, maximum diameter, 35.1 mm+, height, 20.8 mm, $\times 1.5$. All specimens are silicon-rubber casts.

growth rugae toward adult whorls. Slit band of the spire whorls appears just above the lower sutures. Slit moderately deep.

Discussion: This species is very rare at locality PCL6-53-1 and only five specimens have been collected, among which three are very fragmental. The holotype is compressed laterally so that the shape of the body whorl is more or less different from the

original. The basal whorl surface of the body whorl is convex in this specimen, but the convexity seems to be accentuated by lateral compression. The variation is mainly manifested by the shell outline. The height of the spire seems to be variable to some extent. In one of the paratypes (Fig. 6E-H) the early whorls are depressed in the penultimate whorl, but the penultimate whorl is elevated slightly in the body whorl. However, all spire whorls are depressed into the body whorl of the holotypes (Fig. 6A-B). The ornamentation of the basal whorl surfaces is rather consistent among the five specimens and consists of fine prorsiradiate axial ribs in the early whorls. These ribs gradually weaken toward the adult whorls and are broken into rugae.

The Nakazato taxon seems to be atypical for the genus because its shell shape is nearly planispiral. However, the presence of a slit and a slit band slightly below the upper whorl carina in this species suggests that it can be assigned to *Euryzone*. The Nakazato taxon is clearly separable from all the species of *Euryzone* by its planispiral shell shape, bicarinate whorls, very wide umbilicus and the presence of fine prorsiradiate axial ribs on the early basal whorl surfaces. Among these species, *E. onoi* most resembles *Euryzone pharkidopyndax* LINSLEY, 1968 from the Middle Devonian Anderdon Limestone of the United States, but differs in that the shell size is larger, the spire is much lower and the upper whorl surfaces are more prominently concave than *E. pharkidopyndax* and the shell ornamentation is quite different.

E. onoi also resembles *Euryzone latitornata* LINSLEY, 1968 from the Anderdon Limestone, but differs in having a shell about twice as large as well as a depressed spire, more prominently angulated whorls, and the presence of axial ribs on the basal whorl surfaces.

Figured specimens: Holotype, NSM-PM15321; Paratypes, NSM-PM15322–15324.

Etymology: This species is named after Mr. Teruo ONO, who collected further material from the Nakazato Formation.

Superfamily Murchisoniacea KOKEN, 1896

Family Murchisoniidae KOKEN, 1896

Genus *Murchisonia* D'ARCHIAC and DE VERNEUIL, 1841

Subgenus *s. str.*

Murchisonia (Murchisonia) sp.

(Fig. 5A–B)

Discussion: Three imperfect specimens of an apparently undescribed species have been assigned to *Murchisonia (M.)*. They are small and high-spined shells, preserving many inflated and wide whorls. The sutures are deeply impressed. Two weak but sharp spiral cords give rise to a moderately wide selenizone at a point slightly below the midwhorl. Apertural area and apical whorls are missing. The shell surface appears to have very fine spiral ornaments and growth lines. This Nakazato species appears to be separable from other known species of *Murchisonia (M.)* by its wider whorl

profile.

Figured specimens: NSM-PM13525–13526.

Acknowledgements

We are deeply indebted to Mr. Atsushi KANEKO for his notice of the specimens, and also to Mr. Teruo ONO, who assisted one of us (T.K.) to collect the material. Dr. L. MARINCOVICH, Jr. reviewed the manuscript. His suggestions were greatly appreciated. We thank Dr. Teiichi KOBAYASHI for his supervision of our study. This is a contribution to the JTAF (Studies on Japanese Trilobites and Associated Fossils), no. 42.

References

- BATTEN, R. L., 1966. The Lower Carboniferous gastropod fauna from the Hotwells Limestone of Compton Martin, Somerset. *Palaeont. Soc. Monogr.*, **119** (509): 1–52, pls. 1–5.
- COPPER, P., J. TAZAWA, K. MORI & K. KATO, 1982. *Atrypa* (Devonian Brachiopoda) from Japan. *Trans. Proc. Palaeont. Soc. Japan*, N.S., (127): 368–374, pl. 59.
- DONALD, J., 1905. On some Gastropoda from the Silurian rocks of Liangadock (Caermarthenshire). *Quart. J. Geol. Soc. London*, **61**: 567–577, pl. 37.
- HORNÝ, R. J., 1962. Lower Paleozoic Bellerophontina (Gastropoda) of Bohemia. *Sb. geol. Ved. Paleont.* **2**: 57–164, pls. 1–44.
- KANEKO, A., 1984. A Middle Devonian trilobite fauna from the Kitakami Mountains, northeast Japan — I. The Lichidae. *Trans. Proc. Palaeont. Soc. Japan*, N.S., (136): 474–491, pls. 87–89.
- , 1985. Ditto — II. The Calymenidae. *Ibid.*, (138): 94–110, pls. 14–16.
- KASE, T., T. NISHIDA & S. NIKO, 1985. *Boiotremus fukujiensis*, n. sp. from Fukuji, Gifu Prefecture — First recorded Devonian gastropod from Japan. *Mem. Nat. Sci. Mus.*, Tokyo, (18): 29–35, pl. 1.
- KNIGHT, J. B., 1941. Paleozoic gastropod genotypes. *Geol. Soc. Amer., Spec. Pap.*, (32): 1–510, pls. 1–96.
- , 1954 a. Some new genera of the Bellerophontacea. *J. Paleont.*, **19**: 333–340, pl. 49.
- , 1945 b. Some new genera of Paleozoic Gastropoda. *Ibid.*, **19**: 573–587, pls. 79–80.
- , R. L. BATTEN & E. L. YOCHELSON, 1960. Part I, Mollusca. In MOORE, R. C. (ed.), *Treatise on Invertebrate Paleontology*. Geol. Soc. Amer. and Univ. Kansas Press, pp. 1169–1351.
- LINSLEY, R. M., 1968. Gastropods of the Middle Devonian Anderdon Limestone. *Bull. Amer. Paleont.*, **54**: 333–465, pls. 25–39.
- MINATO, M. & M. KATO, 1977. A reticulate spiriferid from the Nakazato Formation of the Kitakami Mountains, Japan. *J. Fac. Sci., Hokkaido Univ.*, ser. 4, **17**: 619–627, pl. 1.
- *et al.*, 1979. *The Abean Orogeny*. 427 p., 144 pls. Tokai Univ. Press, Tokyo.
- OKUBO, M., 1950. On the Gotlandian and the Devonian deposits of Hikoroichi, Kesen-district, Iwate Prefecture. *J. Geol. Soc. Japan*, **56**: 345–350. (In Japanese.)
- , 1951. Trilobites from Japan. *Chikyu-kagaku*, (4): 133–139, pl. 1. (In Japanese.)
- , 1956. Some Devonian brachiopods and trilobites of the Southern Kitakami Mountainland. *Japan. J. Geol. Geogr.*, **27**: 37–45, pls. 1–3.
- PEDDER, A. E. H., 1966. The Upper Devonian gastropod *Orecoxia* in western Canada. *Palaeontology*, **9**: 142–147.
- ROLLINS, H. B., N. ELDRIDGE & J. SPILLER, 1971. Gastropoda and Monoplacophora of the Solville Member (Middle Devonian Marsellus Formation) in the Chenango Valley, New York State. *Bull. Amer. Mus. Nat. Hist.*, **144**: 129–170.

- SUGIYAMA, T. & H. OKANO, 1941. On the discovery of *Phacopus* (*s.s.*) from the Nakazato Series (Middle Devonian) of the Kitakami Mountainland, Japan. *J. Geol. Soc. Japan*, **48**: 357–361.
- TALENT, J. A., 1963. The Devonian of the Mitchell and Wentworth Rivers. *Mem. Geol. Surv. Victoria*, **23**: 1–275, pls. 1–78.
- TASSELL, C. B., 1976. A revision of the gastropod fauna of the Lilydale Limestone (Early Devonian) of Victoria. *Mem. Nat. Mus. Victoria*, (37): 1–22, pls. 1–3.
- , 1978. Gastropods from the Early Devonian Bell Point Limestone, Cape Liptrap Peninsula, Victoria. *Ibid.*, (39): 19–32, pl. 1.
- , 1982. Gastropods from the Early Devonian “*Receptaculites*” Limestone, Taemas, New South Wales. *Rec. Queen Victoria Mus.*, (77): 1–59, pls. 1–6.
- WALCOTT, C. D., 1884. Paleontology of the Eureka district (Nevada). *U. S. Geol. Survey Monogr.*, (8): 1–298, 24 pls.
- YOCHELSON, E. L., 1956. Permian Gastropoda of the Southwestern United States: 1. Euomphalacea, Trochonematacea, Pseudophoracea, Anomphalacea, Craspedostomatacea, and Platyceratacea. *Bull. Amer. Mus. Nat. Hist.*, **110**: 173–276, pls. 9–24.

