Palaeontologia Electronica
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ILLUSTRATION AND TAXONOMIC REEVALUATION OF NEOGENE FORAMINIFERA DESCRIBED FROM JAPAN

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ABSTRACT

A Scanning Light Microscope (SLM) is used to illustrate 145 Neogene foraminiferal taxa described in the Japanese literature over the past 100 years. The SLM permits photography of specimens without coating, in contrast to some scanning electron microscopes, and provides in-focus (no depth-of-field problem) color photomicrographs of each specimen, which is essential to observing detail as would be seen with a dissecting microscope.

Some groups for which there is little taxonomic agreement, such as the unilocular forms and some miliolids, are not illustrated. Where the authors' views on the taxonomy diverge, the different opinions are discussed.

Three new species are described (by Takayanagi): Eggerella matsunoi, Haplophragmoides hatai, and Haplophragmoides nishikizawensis.

The main purpose of this work is to illustrate some common and not-so-common forms that are poorly known in the North American and European literature and whose names are sometimes used incorrectly. This should help authors worldwide compare their species with the Japanese types in order to reconcile regional taxonomic inconsistencies.

Key words: foraminifera, Neogene, scanning light photography, color pictures, slides.

Submission: 31 March 2000, Acceptance: 18 August 2000

INTRODUCTION

For more than 100 years, researchers in Japan, primarily at Tohoku University in Sendai, have been actively studying micropaleontology (specifically, foraminifera). This tradition was started by the late Professor Yabe, but probably blossomed and became known worldwide as a result of the work of the late Professor K. Asano in the 1950s and 1960s. Despite the fact that some species names used in other parts of the world originated with the work done in Japan and many Western workers have visited Tohoku University to examine various species, the collections are poorly known outside of Japan.

Because so much of the research done in Japan was based at Tohoku University, the best collections of holotypes are there. When the senior author first visited Sendai in 1990, it was to examine a narrow range of species that had importance on the east coast of North America. It soon became apparent that there was much more to examine and that the whole community of researchers studying foraminifera should be made aware of these collections.

The standard method of photography is the scanning electron microscope (SEM), but that process is partly destructive because the specimens must be metal coated and the method is thus not suitable for type specimens. Since that time the environmental scanning electron microscope (ESEM), which requires no coating, has been developed. But as any researcher who has tried to identify transparent calcareous species from SEM photos knows, the SEM photo and what is observed under a dissecting scope are not comparable. Problems in depth of field limit the usefulness of ordinary light microscopic photography.

However, a commercially available technique using a Scanning Light Microscope (SLM) allows in-focus pictures of small objects such as foraminifera (Gerakaris 1986; Scott and Vilks 1991). This technique is relatively quick and nondestructive and was deemed appropriate to illustrate as many Japanese Neogene type specimens as could be located.

In addition to fully illustrating species, we felt it important to evaluate each species for possible affinities with other species described in the literature. Although our evaluations are subjective, they should make it easier to compare Japanese species with those observed in Europe and North America as well as improve the usage of taxonomy worldwide. Many who have worked between the east and west coasts of North America can sympathize with “local” taxonomic problems. It is also clear that several Japanese species probably occur in the North Atlantic, but a lack of familiarity with the Japanese types has restricted usage of these names.

We are qualified to help with some of these problems because all the authors of this paper have experience in most of the world’s oceans over a full range of environments. Of the authors, Scott has the most familiarity with the North Atlantic material, which is important here because many of the oldest and most “established” species were first defined in the North Atlantic by early European workers; Takayanagi, Hasegawa, and Saito have more experience in the Pacific and especially with the Japanese material. This knowledge was particularly important in assessing the species because in many cases the types (as we will discuss later) are not representative of the range of variability of particular species.

We hope that the re-illustration of the species here will provide benthic foraminiferal reseachers worldwide with access to this important Japanese collection.

In addition to the existing published species, we include three new species, which are described by Takayanagi.

LIMITATIONS

It became obvious fairly quickly that we could not photograph every Japanese Neogene type. Even the ones within Tohoku University were not always present or were broken beyond any recognition. There were also quite a large number of species described at other places by workers now either retired or deceased and unfortunately many of these holotypes are either lost or taken home by individual workers, not placed in a national museum. Hence some species that may be familiar to western workers are not illustrated in our collection simply because we could not obtain specimens. We apologize in advance for some of these omissions. We were fortunate to obtain some specimens from the National Science Museum (Tokyo, Shinjuku Branch) which we did illustrate and discuss here.

We did not include some foraminiferal groups in this publication because the species are usually relatively rare and there is no agreement in the field about their taxonomy. These groups include all the unilocular forms (e.g., **Fissurina, Oolina, Lagena**), the miliolids, and most of the polymorphinids. In addition, most of these species are too small to be adequately photographed with the SLM system.

We tried to limit our project to photographing original holotypes. However, some holotypes are more than 70 years old and have been etched by previously used mounting techniques. This has made some specimens difficult to base species identifications on, but we have included them because they are holotypes. In these cases we have included the comments of Hasegawa and Takayanagi describing some of the distinguishing features that are not visible on the holotypes.

Sometimes more than one specimen on a slide was labeled as “holotype”. For those, Scott selected a “syntype” for illustration that he thought was the most representative of the specimens.

METHODS

We used the SLM to photograph all the species that we discuss. The SLM takes a composite photograph of the specimen as it moves through a lighted focal plane that has a bandwidth of 50-100 micrometers so that the photograph only records the sections that are lighted and in focus. Although new digital electronic cameras on microscopes allow a micrograph to be “assembled” from a group of photo “slices” pieced together electronically, with current technology electronic resolution is still much less than that of film and the image cannot be significantly enlarged without losing resolution.

The major limitation of the SLM is that the light bandwidth is sometimes more than the width of some smaller species. Another limitation, related to the light bandwidth, is the magnification obtainable with our system—its maximum is 40x—which is not sufficient for some of the smaller species, but it may explain why even with the smaller species we get good photographs. The images are in focus and can be enlarged photographically, so they are better than ones taken at higher magnifications with other photographic systems. Finally, from a technical point of view, the horizontal, narrow band lighting means that specimens must be mounted in such a way that the light will get into critical regions such as umbilical cavities. Some features are virtually impossible to light; hence, some photographs have dark areas that are unavoidable. Also, some of the angles of specimens are not the "standard" views that micropaleontologists are accustomed to with SEM photographs.

We used Fuji 64T® color slide film (35 mm) for the photographs. In some cases 10 x 10 cm sheet film might have been better, but it could not be used to produce a slide. We used slide film because with slides it is possible to enlarge them on a screen to whatever size necessary to examine them. The slides are reproduced here in plates 1–14 after being scanned into Adobe® Photoshop and electronically adjusted for contrast and brightness. These are second-generation reproductions; the originals are high resolution color slides that have a dpi of probably 5000-6000 (as opposed to the scan resolution of 720 dpi of the electronic scans). Copies of the original slides are available (see the appendix for availability).

DISCUSSION

The subjective assessments of the affinities for the Japanese Neogene species illustrated in this paper are detailed in the taxonomic section, but we summarize some of the findings in this section.

In this paper we describe 145 species: 80 species that in our opinion appear to be distinct species, 47 that are junior synonyms of older forms described in either the Japanese or European literature, and 18 species about which we were unsure.

We disagreed among ourselves about the placement of some species, but that is the nature of subjective taxonomy; these differences in opinion between the authors are discussed under those species. Some specimens were too badly preserved for us to make a precise identification.

Two species that we describe are prominent in North Atlantic deep-sea faunas: **Tosaia hanzawai** Takayanagi (often confused with **Eggerella bradyi** Cushman) and **Epistominella takayanagii** Iwasa, which has previously been called a variety of names, all of them incorrect.

At least two Japanese species names are senior synonyms of some common North Atlantic forms and therefore take precedence over them: **Cassidulina sagamiensis** Asano and Nakamura (1937) is the valid name for **Islandiella islandica** Nørvang (1945) and **Pseudononion japonicum** Asano (1936b) is the valid name for **Nonionella atlantica** Cushman (1947).

One species that we must discuss here even though we did not photograph or examine the types is **Eponides nipponica** (Kuwano) (Matoba 1967). This particular species is a problem because the author is deceased. Although Scott retrieved Kuwano's holotypes from the National Science Museum, many of his specimens, including **Eponides nipponica,** were not in the slides because the slides did not have cover slips. Takayanagi discussed the issue with Matoba, who assured us he had seen Kuwano’s original type and had actually encouraged him at the time to publish his then-unpublished species in the 1967 paper. Subsequently, many workers have used the name **E. nipponica** for a common species in the North Atlantic, which is certainly **Eponides weddellensis** (Earland 1936), by other referred to **Alabaminiella**. Because **Eponides nipponica** is a junior synonym of **E. weddellensis,** the latter should be used as the valid name for this common deep sea species**.**

TAXONOMY

In this section are listed all the species we were able to illustrate. The species designation as originally published is used here to avoid confusion. If the genus changed subsequently, we list

the reference. If we decided that a species was originally placed in an incorrect genus, or was otherwise improperly designated, we summarize our reasoning.

As might be expected, for several species, we had discussions regarding the affinity of the species; in these cases we have tried to represent the opinions of each author accurately. In general, Scott is more of a taxonomic “lumper”; Takayanagi and Hasegawa are more conservative.

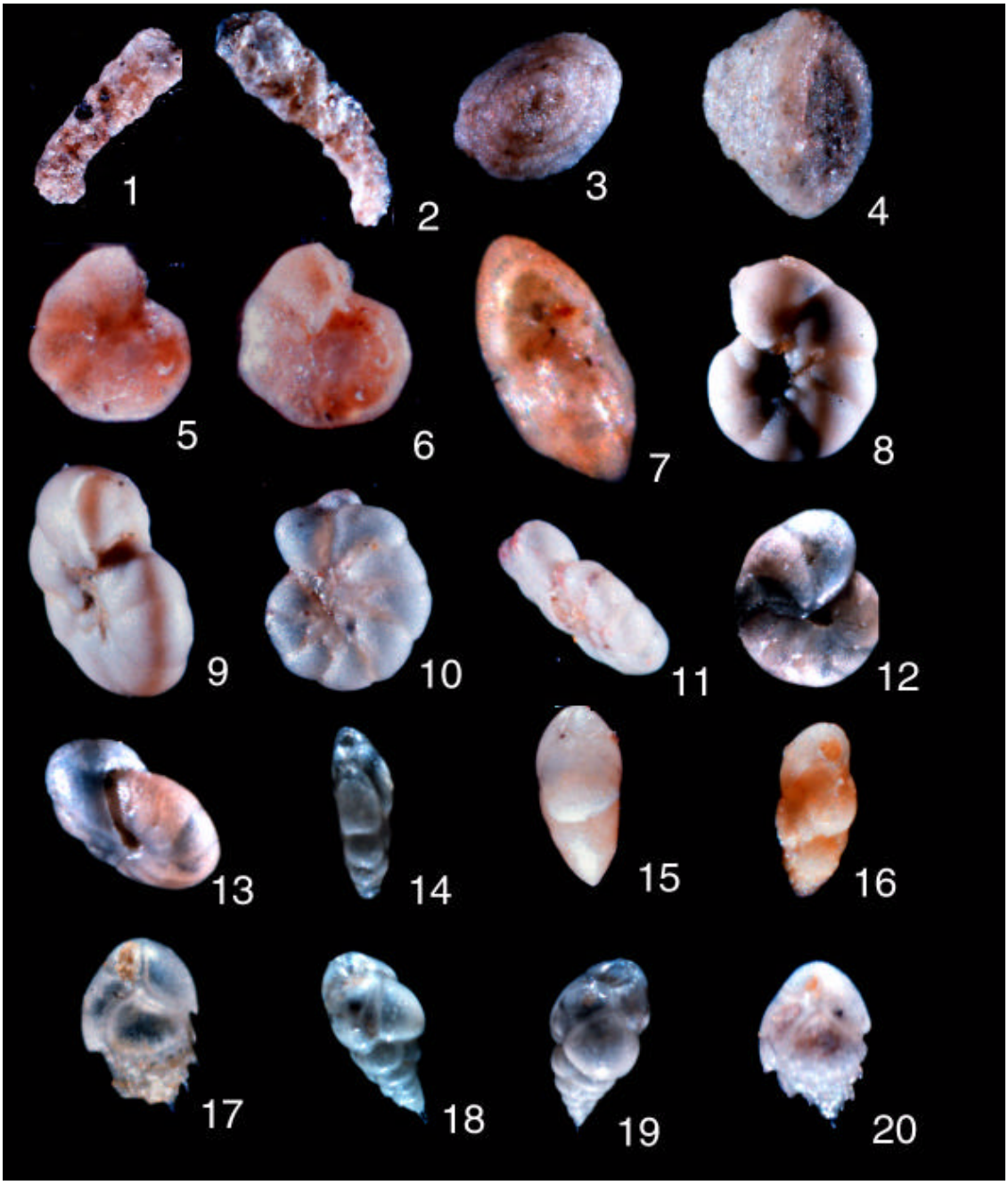
The figure numbers listed for each species correspond to the slide-collection numbers and should be referenced specifically if you desire to obtain any one or all of this slide collection (see Appendix). All Japanese types and their references are listed in Takayanagi and Hasegawa (1987).

The plates are organized by the slide-collection numbers: Figure 1 consists of 1.1-1.20, Figure 2 consists of 2.21-2.40, and so on, to Figure 14, which consists of 14.261-14.278.

TAXONOMIC LISTINGS

Throughout taxonomic list the abbreviation LD = longest dimension. The dimensions are given in millimeters. See pages 5–37.

Figure 1.1-20. Ammobaculites formosensis Nakamura. 1.1: side view, 25x (LD = 1.12 millimeters). 1.2: aperture view, 13.5x (LD = 1.48 millimeters). **Ammodiscoides japonicus** Asano and Inomata, **in** Asano. 1.3: "dorsal" view of cone side up, 13.5x (LD = .81 millimeters). 1.4: side apertural view of "ventral" side. 13.5x (LD = .81 millimeters). **Anomalina nipponica** Asano and Inomata **in** Asano. 1.5: dorsal view, 45x (LD = .33 millimeters). 1.6: ventral view, 45x (LD = .33 millimeters). **Anomalina nipponica** Asano and Inomata **in** Asano. 1.7: edge view, 45x (LD = .33 millimeters). **Astrononion aomoriense** Asano 1.8: side view, 13.5x (LD = .33 millimeters). 1.9: edge view showing aperture, 13.5x (LD = .33 millimeters). **Astrononion hamadaense** Asano, 1.10: side view, 13.5x (LD = .81 millimeters). 1.11: edge view, 13.5x (LD = .81 millimeters). **Astrononion hanyudaense** Matsunaga 1.12: side view, 45x (LD = .53 millimeters). 1.13: edge apertural, 45x (LD = .51 millimeters). **Bulimina honjoensis** Iwasa 1.14: side view, 45x (LD = .42 millimeters). **Bulimina kamedaensis** Matsunaga 1.15: side apertural view, 13.5x (LD = 1.63 millimeters). **Bulimina kochiensis** Takayanagi 1.16: side apertural view, 45x (LD = .33 millimeters). **Bulimina nipponica** Asano 1.17: side view, 45x (LD = .62 millimeters). **Bulimina nojimaensis** Asano 1.18: side view, 13.5x (LD = 1.11 millimeters). **Bulimina nojimaensis** Asano 1.19: slanted side view of aperture, 13.5x (LD = 1.03 millimeters). **Bulimina striata** d'Orbigny **notoensis** Asano 1.20: side view of aperture, 45x (LD = .40 millimeters).



Ammobaculites formosensis Nakamura (1937, p. 133, pl. 10, figure 1a-1b). 1.1. Side view, 25x (LD = 1.12 millimeters). 1.2. Aperture view, 13.5x (LD = 1.48 millimeters). Photographs of the hypotype (#75249) by Asano (1952) in Tohoku University collections. This species appears very similar to **A. exiguus** (Cushman and Brönnimann 1948) with a tight coil and narrow neck. The holotype is a good specimen and the figures are representative of specimens seen under a dissecting microscope.

Ammodiscoides japonicus Asano and Inomata (in Asano 1952, p. 3, figures 9-11). 1.3. "Dorsal" view of cone side up, 13.5x (LD = .81 millimeters). 1.4. Side apertural view of "ventral" side, 13.5x (LD = .81 millimeters). Photographs of the holotype (#75255) in Tohoku University collections. This species is not similar to any Scott has seen from North Atlantic collections and appears to be a species unique to this collection.

Anomalina nipponica Asano and Inomata (in Asano 1952, p. 17, figures 95 and 96). 1.5. Dorsal view, 45x (LD = .33 millimeters). 1.6. Ventral view, 45x (LD = .33 millimeters). 1.7. Side view, 45x (LD = .33 millimeters). Photographs of the holotype (#75256) in the Tohoku University collections. Scott would probably place this species in **Cibicides,** but we leave the species name as it is; it appears to be unique to this collection.

Astrononion aomoriense Asano (1950a, p. 5, figures 27 and 28). 1.8. Side view, 13.5x (LD = .33 millimeters). 1.9. Edge view showing aperture, 13.5x (LD = .33 millimeters). Photographs of specimen #66118 from Tohoku University collections. The slide was not designated as having a holotype, and it contained several individuals; however, it was the only slide of this species in the collection. Although it has a radial structure in the umbilical area, it is not similar to the type species of this genus. Unlike **A. gallowayi** (Loeblich and Tappan 1953), it has no perforations in the test.

Astrononion hamadaense Asano (1950a, p. 6, figures 29-31). 1.10. Side view, 13.5x (LD = .81 millimeters). 1.11. Edge view, 13.5x (LD = .81 millimeters). Specimen photographed from slide #66119 in the Tohoku University collection with several specimens on it, none of which were designated as the holotype. This species is conspecific with **A. gallowayi** Loeblich and Tappan (1953) and thus **A. hamadaense** has priority**.** This is an example of the valid name being ignored in the European and North American literature because of a lack of knowledge of the Japanese collections.

Astrononion hanyudaense Matsunaga (1963, p. 107, pl. 35, figure 8a-8b).1.12. Side view, 45x.(LD = .53 millimeters). 1.13. Edge view showing aperture, 45x (LD = .51 millimeters). Photographs of the holotype (#85179) in the Tohoku University collections. Scott would place this species into **Melonis** or **Nonion** under a series of names that all work themselves back to **Nonion affine** (Reuss 1851); Hasegawa maintains that this is an **Astrononion** on the basis of the extensions that appear in the umbilical area**.**

Bulimina honjoensis Iwasa (1955, p. 16, text figure 1a-1b). 1.14. Side view, 45x (LD = .42 millimeters). Photograph of the holotype (#65501) in the Tohoku University collections. This is a specimen that Scott would place into **Fursenkoina fusiformis** (Williamson 1858); Hasegawa would place it closer to **Bulimina tenuata** (Cushman 1927).

Bulimina kamedaensis Matsunaga (1963, p. 111, pl. 40, figure 2a-2b). 1.15. Side view showing aperture, 13.5x (LD = 1.63 millimeters). Photograph of the holotype (#85225) in the Tohoku University collections. The specimen appears to have an etched surface, so is difficult to identify.

Bulimina kochiensis Takayanagi (1953, p. 31, pl. 4, figure 12a-12c). 1.16. Side view showing aperture, 45x (LD = .33 millimeters). Photograph of the holotype (#67139) in the Tohoku University collections. The specimen is badly etched, which obscures some of the critical features, but it appears similar to **B. marginata** d'Orbigny (1826). However, Takayanagi notes that well preserved specimens are not similar to **B. marginata**.

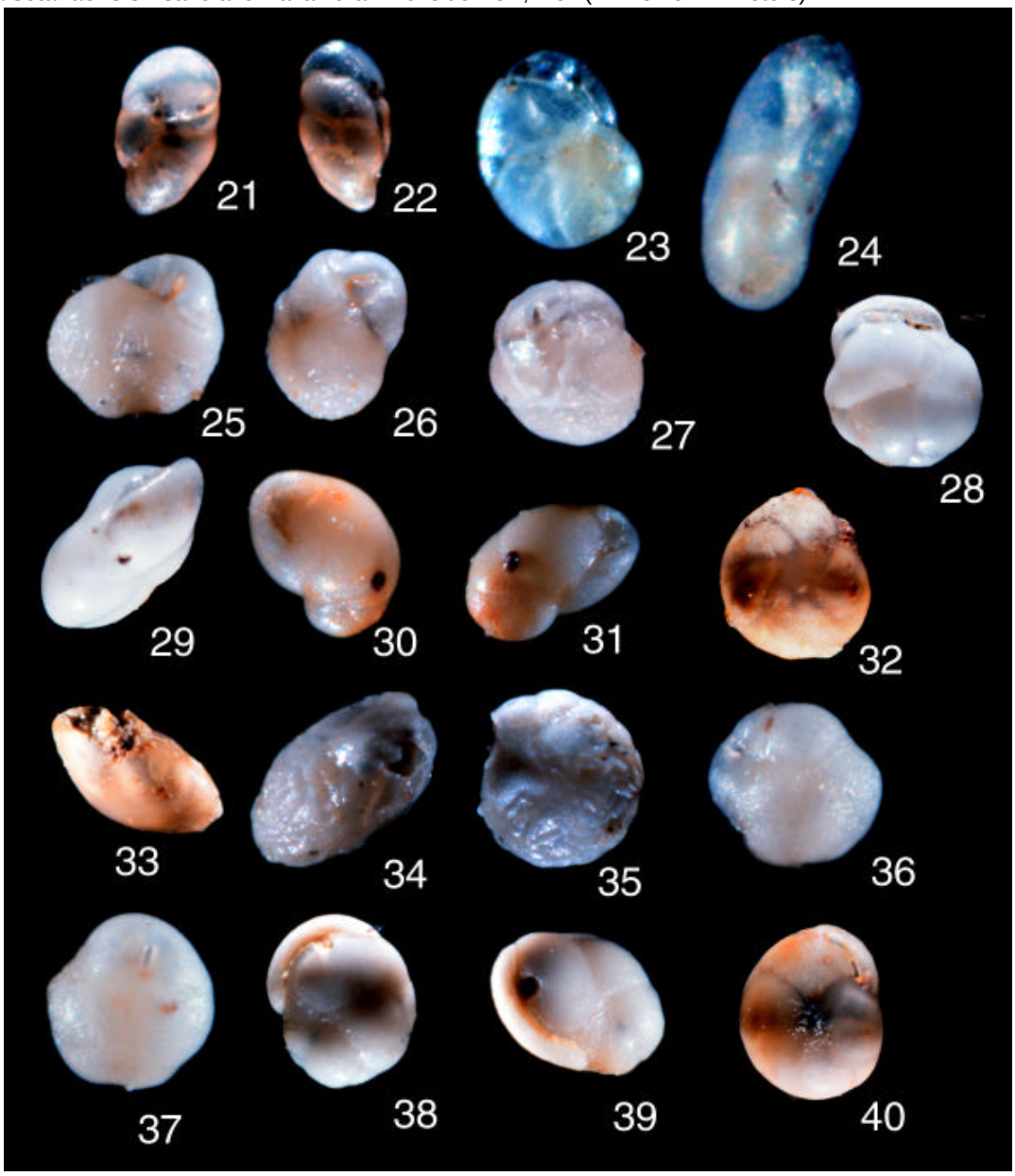
Bulimina nipponica Asano (1958, p. 6, pl. 1, figures 13-15). 1.17. Side view, 45x (LD = .62 millimeters). Photograph of a paratype from Shiwoya-zaki (station 24) from a slide labeled 25 (#77168) in the Tohoku University collections. The holotype (Asano 1958, pl. 1, figure 14) is from station 346 in the Kii Channel. This specimen is identical to **Bulimina striata** d'Orbigny (1826) and should be considered a junior synonym of that species.

Bulimina nojimaensis Asano (1950b, p. 4, figures 15-16). 1.18. Side view, 13.5x (LD = 1.11 millimeters). 1.19. Slanted side view showing aperture, 13.5x (LD = 1.03 millimeters). Photographs of specimen #66940 in the Tohoku University collections. This specimen was not labeled as the holotype.

Bulimina striata d'Orbigny **notoensis** Asano (1953a, p.11, pl. 2, figures 16-17). 1.20. Side view

showing aperture, 45x (LD = .40 millimeters). Photograph of the holotype labeled as #219 (#75282) in the Tohoku University collections. This species is indistinguishable from Asano's **B. nipponica** or from **B. striata**

Figure 2.21-40. Buliminella hanzawai Asano 2.21: apertural side view, 10x (LD = 1.70 millimeters). 2.22: opposite side view, 10x (LD = 1.80 millimeters). **Cassidulina complanata** Ujiie and Kusukawa 2.23: side aperture, 15x (LD = .87 millimeters). 2.24: edge apertural view, 15x (LD = .87 millimeters). **Cassidulina crepidula** Kuwano 2.25: side apertural view, 45x (LD = .44 millimeters). **Cassidulina elegans** Sidebottom **var. bosoensis** Kuwano 2.26: edge aperture, 45x (LD = .44 millimeters). 2.27: side aperture, 45x (LD = .36 millimeters). **Cassidulina japonica** Asano and Nakamura 2.28: side view, 10.5x (LD = 10.00 millimeters). 2.29: slanted side view, 10.5x (LD = 10.00 millimeters). **Cassidulina kattoi** Takayanagi 2.30: aperture up view, 45x (LD = .33 millimeters). 2.31: side view, 45x (LD = .36 millimeters). **Cassidulina kazusaensis** Asano and Nakamura 2.32: side view, 15x (LD = 1.53 millimeters). 2.33: edge view, 15x (LD = 1.53 millimeters). **Cassidulina nojimana** Kuwano 2.34: slanted apertural view, 45x (LD = .44 millimeters). 2.35: side view, 45x (LD = .47 millimeters). **Cassidulina paratortuosa** Kuwano 2.36: side aperture view, 45x (LD = .29 millimeters). 2.37: edge apertural view, 45x (LD = .29 millimeters). **Cassidulina sagamiensis** Asano and Nakamura 2.38: side view, 37.5x (LD = .56 millimeters). 2.39: edge apertural view, 37.5x (LD = .56 millimeters). **Cassidulina setanaensis** Asano and Nakamura 2.40: side view, 7.5x (LD =3.20 millimeters).



Buliminella hanzawai Asano (1949, p. 428, figure 1, nos. 54-55). 2.21. Side view showing aperture, 10x (LD = 1.70 millimeters). 2.22. Side view of non-apertural side, 10x (LD = 1.80 millimeters). Photographs of holotype (#67048) in the Tohoku University collections. This species is part of the highly variable **Robertinoides charlottensis** (Cushman 1925). The species was shifted into the genus **Robertina** by Asano (1950b), but it is still the junior synonym of **R. charlottensis** (see Scott and Vilks 1991).

Cassidulina complanata Ujiie and Kusukawa (1969, p. 766, pl. 1, figures 1 and 2). 2.23. Side view showing aperture, 15x (LD = .87 millimeters). 2.24. Edge view showing aperture, 15x (LD = .87 millimeters).

Photographs of the holotype (#242, 243) from the National Science Museum (Tokyo, Shinjuku branch). This species appears different from the other species of **Cassidulina** because of its long apertural slit.

Cassidulina crepidula Kuwano (1954a, p. 33, figures 1-3). 2.25. Side view showing aperture, 45x (LD = .44 millimeters). Photograph of one of several species named by Kuwano and discovered (no numbers) by personnel at the National Science Museum (Tokyo, Shinjuku branch) when we looked through Kuwano's collections after his untimely death in 1989. This species is well preserved and appears to be a distinct species.

Cassidulina elegans Sidebottom **var. bosoensis** Kuwano (1954a, p. 34, figures 7-11). 2.26. Edge view showing aperture, 45x (LD = .44 millimeters). 2.27. Side view showing aperture, 45x (LD = .36 millimeters). Photographs of another of the "lost" species of Kuwano with no museum number (see 2.25). The specimen photographed looks like the paratype and was the best of all the specimens left on the slide. It appears outwardly similar to **C. subglobosum** (Brady 1881); however, it has a crenulated surface so is believed to be a distinct species.

Cassidulina japonica Asano and Nakamura (1937, p. 144, pl. 13, figures 1 and 2, text figure 2a-2b). 2.28. Side view, 10.5x (LD = 10.00 millimeters). 2.29. Slanted side view, 10.5x (LD = 10.00 millimeters). Photographs of the holotype (#21434) in the Tohoku University collections. This species may fit into **Islandiella,** but whatever its generic affinities, it does appear to be a distinct species. Nomura (1983b) places this species in **Islandiella.**

Cassidulina kattoi Takayanagi (1953, p. 34, pl. 4, figure 10a-10b). 2.30. Apertural view, 45x (LD = .33 millimeters). 2.31. Side view, 45x (LD = .36 millimeters). Photographs of the holotype (#67144) in the Tohoku University collections. As with many of the cassidulinids, the variability is so high that it is difficult to say if this is a distinct species or a junior synonym of another species.

Cassidulina kazusaensis Asano and Nakamura (1937, p. 146, pl. 14, figure 2a-2b, text figure 7a-7b). 2.32. Side view, 15x (LD = 1.53 millimeters). 2.33. Edge view, 15x (LD = 1.53 millimeters). Photographs of the holotype (#21438) of the Tohoku University collections. This specimen is broken at the aperture and therefore difficult to compare, but its overall form is very different from other cassidulinids.

Cassidulina nojimana Kuwano (1954b, p. 79, figures 2 and 3). 2.34. Slanted apertural view, 45x (LD = .44 millimeters). 2.35. Side view, 45x (LD = .47 millimeters). Photographs of an unnumbered paratype (as with all of Kuwano's material) now in the National Science Museum (Tokyo, Shinjuku branch). Several specimens were on the slide; they looked very similar to Kuwano's **C. elegans v. bosoensis** (Figures 26 and 27), but not like any other cassidulinids.

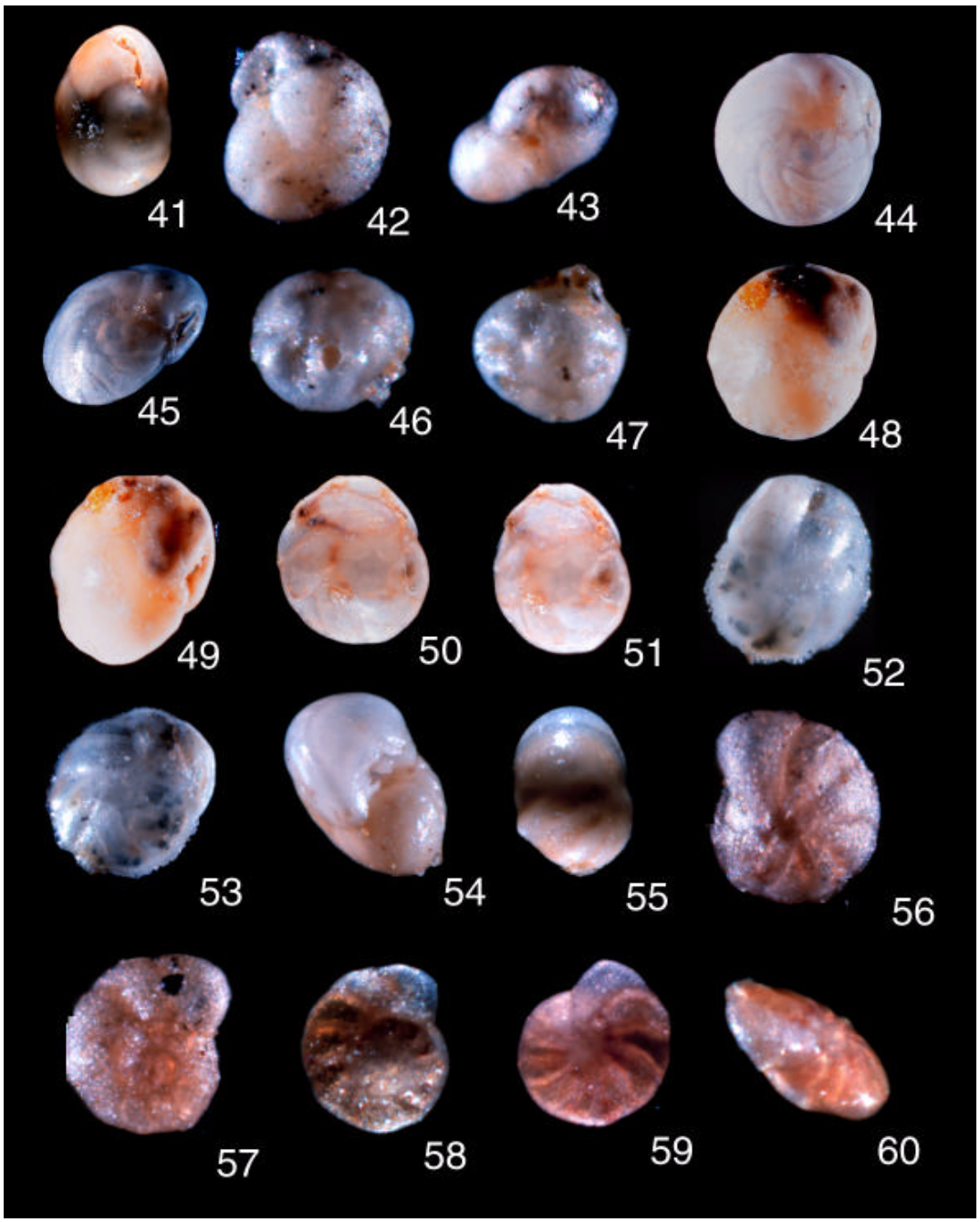
Cassidulina paratortuosa Kuwano (1954a, p. 34, figures 4-6). 2.36. Side view showing aperture, 45x (LD = .29 millimeters). 2.37. Edge view showing aperture, 45x (LD = .29 millimeters). Photographs of an unnumbered paratype in the Tokyo National Museum. These pictures of Kuwano’s types outwardly appear like **C. subglobosa** (Brady 1881), but figures of this species in Nomura (1983a) from hypotypes at Tohoku University are very different with well defined sutures that are not visible on Kuwano’s specimens. Nomura (1983b) assigned this species to the genus **Globocassidulina.**

Cassidulina sagamiensis Asano and Nakamura (1937, p. 147, pl. 14, figure 5a-5c). 2.38. Side view, 37.5x (LD = .56 millimeters). 2.39. Edge view showing aperture, 37.5x (LD = .56 millimeters). Photographs of holotype (#21439) in the Tohoku University collections. This species is very similar to what has been called **Islandiella islandica** (Nörvang 1945) in the Atlantic, but this species is an older name and would take precedence. Nomura (1983a) suggested this species has a typical **Paracassidulina** aperture.

Cassidulina setanaensis Asano and Nakamura (1937, pl. 13, figure 7a-7b). 2.40. Side view, 7.5x (LD = 3.20 millimeters). Photographs of the holotype (#21437) in the Tohoku University collections.

This species appears similar to **C. kazusaensis** (Figures 32 and 33) to Scott. Nomura (1983b) suggested that **C. kazusaensis** differs by having a "fan shaped" tooth, but the type specimen of this species has a broken aperture, and it is unclear how this "tooth" was observed. He also suggested a narrower periphery, which is not a distinguishing characteristic in these species. (See also 3.41.)

Figure 3.3.41-60. Cassidulina setanaensis Asano and Nakamura 3.41: apertural view, 7.5x (LD = 3.20 millimeters). **Cassidulina subglobosa** Brady **depressa** Asano and Nakamura 3.42: side view, 45x (LD = .38 millimeters). 3.43: edge aperture view, 45x (LD = .36 millimeters). **Cassidulina sublimbata** Asano and Nakamura 3.44: side view, 15x (LD = 1.20 millimeters). 3.45: slanted edge view, 15x (LD = .93 millimeters). **Cassidulina undata** Kuwano 3.46: aperture up view, 45x (LD = .27 millimeters). 3.47: side apertural view, 45x (LD = .24 millimeters). **Cassidulina wakasaensis** Asano and Nakamura 3.48: side view, 15x (LD = 1.33 millimeters). 3.49: slanted edge apertural view, 15x (LD = 1.33millimeters). **Cassidulina yabei** Asano and Nakamura. 3.50: side view, 15x (LD = 1.33 millimeters). 3.51: slanted edge aperture, 15x (LD = 1.33 millimeters). **Cassidulina yabei** Asano and Nakamura **serrata** Matsunaga 3.52: side view, 22.5x (LD = .67 millimeters). 3.53: side aperture view, 22.5x (LD = .67 millimeters). **Ceratobulimina hanzawai** Asano 3.54: side aperture, 37.5x (LD = .61 millimeters). 3.55: opposite side, 37.5x (LD = .61 millimeters). **Cibicides asanoi** Matsunaga 3.56: ventral view, 25x (LD = .76 millimeters). 3.57: dorsal view, 25x (LD = .76 millimeters). **Cibicides cushmani** Ujiie and Kusukawa 3.58: ventral view, 45x (LD = .40 millimeters). 3.59: dorsal view, 45x (LD = .40 millimeters). 3.60: edge view, 45x (LD = .40 millimeters).



3.41. Apertural view, 7.5x (LD = 3.20 millimeters) (continued from 2.40).

Cassidulina subglobosa Brady **depressa** Asano and Nakamura (1937, p. 148, pl. 13, figure 8a-8c). 3.42. Side view, 45x (LD = .38 millimeters). 3.43. Edge view showing aperture, 45x (LD = .36 millimeters). Photographs of holotype (#21441 [#97208hyp]) in Tohoku University collections. Although our pictures do not show it, Nomura (1983b) showed a "**bisecta**" like aperture for this species.

Cassidulina sublimbata Asano and Nakamura (1937, p. 146, pl. 14, figures 3 and 4a-b). 3.44. Side view, 15x (LD = 1.20 millimeters). 3.45. Slanted edge view, 15x. (LD = .93 millimeters) Photographs of holotype (#21442) in the Tohoku University collections. Although similar to C**. kazusaensis** and **C. setanaensis**, it is distinct on the basis of more distinct suture lines and a keeled periphery.

Cassidulina undata Kuwano (1954b, p. 80, figures 3 and 4). 3.46. Apertural view, 45x (LD = .27 millimeters). 3.47. Side view showing aperture, 45x (LD = .24 millimeters). Photographs of what Kuwano called an "ideotype" (no number) in the Tokyo National Museum. This small specimen is similar to some others, but in such poor condition that it is difficult to tell whether it is a distinct species.

Cassidulina wakasaensis Asano and Nakamura (1937, pl. 14, figure 7a-7c). 3.48. Side view, 15x (LD = 1.33 millimeters). 3.49. Slanted edge view showing aperture, 15x (LD = 1.33 millimeters). Photographs of the holotype (#21436) in the Tohoku University collections. Scott feels this species is similar to **C. kazusaensis;** however, Takayanagi disagrees because of specimens he has examined and also points out they have different geographical distributions.

Cassidulina yabei Asano and Nakamura (1937, p. 145, pl. 14, figure 1a-1b). 3.50. Side view, 15x (LD = 1.33 millimeters). 3.51. Slanted edge view showing aperture, 15x (LD = 1.33 millimeters). Photographs of the holotype (#21435) in Tohoku University collections. This species appears to be part of the **C. kazusaensis** group, all of which seem to have been described in the same publication. If these species (**C. kazusaensis, setanansis, yabei**) are all the same, then **setanansis** would be the senior name: it appears on plate 13 and the others are on plate 14 (Asano and Nakamura 1937).

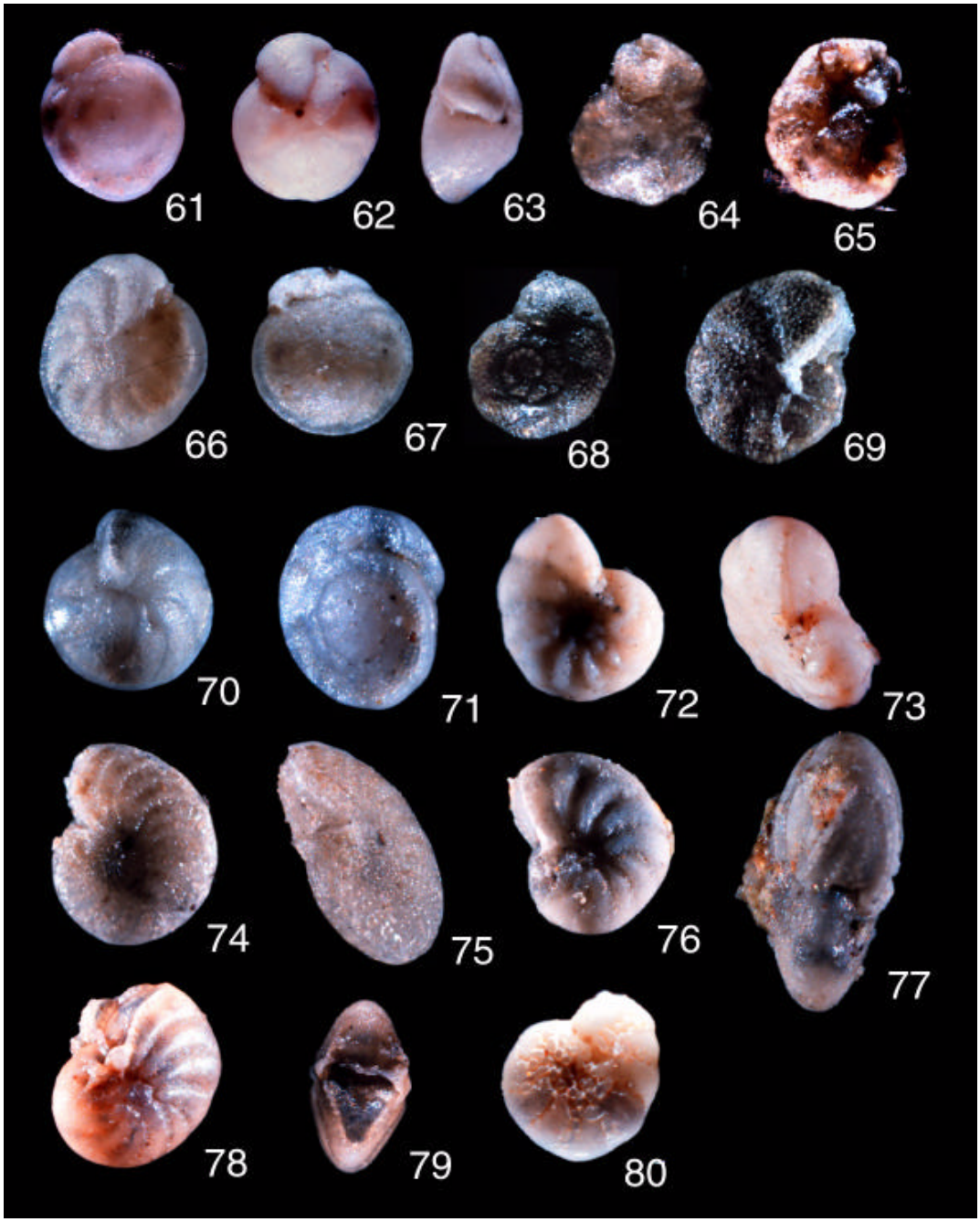
Cassidulina yabei Asano and Nakamura **serrata** Matsunaga (1963, pl. 49, figure 3a-3b). 3.52. Side view, 22.5x (LD = .67 millimeters). 3.53. Side view showing aperture 22.5x (LD = .67 millimeters). Photographs of holotype (#85355) in the Tohoku University collections. Matsunaga neglected to describe this species, but he did provide some good photographs. This species is distinct with a serrated edge on the periphery. It would appear to a variation of the well known North Atlantic species **Islandiella teretis** (Tappan 1951), but perhaps is a distinct species.

Ceratobulimina hanzawai Asano (1949, p. 428, figure 2, nos. 23-27). 3.54. Side aperture, 37.5x (LD = .61 millimeters). 3.55. Opposite side, 37.5x (LD = .61 millimeters). Photographs of holotype (#67046) in the Tohoku University collections. This looks like a distinct species.

Cibicides asanoi Matsunaga (1963, p. 116, pl. 51, figure 4a-4c). 3.56. Ventral view, 25x (LD = .76 millimeters). 3.57. Ddorsal view, 25x (LD = .76 millimeters). Photographs of the holotype (#85376) in the Tohoku University collections. This **Cibicides** species, like many others, is very similar to the old **C. lobatulus** (Walker and Jacob **in** Kanmacher 1798), which takes precedence over any modern name.

Cibicides cushmani Ujiie and Kusukawa (1969, p. 769, pl. 3, figures 1-3, pl. 5, figure 3). 3.58. Ventral view, 45x (LD = .40 millimeters). 3.59. Dorsal view, 45x (LD = .40 millimeters). 3.60. Edge view, 45x (LD = .40 millimeters). Photographs of holotype (#250) in the Tokyo National Museum. This appears to be another variant of **C. lobatulus.**

Figure 4.61-80. Cibicides inagawaensis Matsunaga 4.61: dorsal view, 22.5x (LD = .98 millimeters). 4.62: ventral view, 22.5x (LD = .98 millimeters). 4.63: edge view, 22.5x (LD = .98 millimeters). **Cibicides kamadai** Asano 4.64: dorsal view, 37.5x (LD = .56 millimeters), 4.65: ventral view, 37.5x (LD = .56 millimeters). **Cibicides malloryi** Matsunaga 4.66: ventral view, 22.5x (LD = .57 millimeters). 4.67: dorsal view, 22.5x (LD = .57 millimeters). **Cibicides(?) omurai** Asano and Inomata **in** Asano 4.68: dorsal view, 13.5x (LD = .74 millimeters). 4.69: ventral view, 13.5x (LD = .74 millimeters). **Cibicides yoitaensis** Matsunaga 4.70: ventral view, 22.5x (LD = .71 millimeters). 4.71: dorsal view, 22.5x (LD = .71 millimeters). **Cribroelphidium aomoriense** Asano. 4.72: side view, 13.5x (LD = 1.26 millimeters). 4.73: edge apertural view, 13.5x (LD = 1.18 millimeters). **Cribroelphidium cribrojenseni** Matsunaga 4.74: side view, 13.5x (LD = 1.11 millimeters). 4.75: edge apertural view, 13.5x (LD = 1.11 millimeters). **Cribroelphidium imanishii** Asano 4.76: side view, 13.5x (LD = 1.18 millimeters). 4.77: edge apertural view, 13.5x (LD = 1.18 millimeters). **Cribroelphidium kannonjiense** Matsunaga 4.78: side view, 13.5x (LD = 1.33 millimeters). 4.79: edge apertural view, 13.5x (LD = 1.26 millimeters). **Cribroelphidium nishiyamaense** Matsunaga 4.80: side view, 13.5x (LD = 1.41 millimeters).



Cibicides inagawaensis Matsunaga (1963, p. 116, pl. 51, figure 5a-5c). 4.61. Dorsal view, 22.5x (LD = .98 millimeters). 4.62. Ventral view, 22.5x (LD = .98 millimeters). 4.63. Edge view, 22.5x (LD = .98 millimeters).
Photographs of holotype (#85377) in Tohoku University collections. This species is not a **Cibicides** species; it may fit into the **Cibicidoides** group and appears to be a distinct species.

Cibicides kamadai Asano (1951a, p. 17, figures 33-35). 4.64. Dorsal view, 37.5x (LD = .56 millimeters). 4.65. Ventral view, 37.5x (LD = .56 millimeters). Photographs of holotype (no number) in Tohoku University collections. It is difficult to say what this specimen is because it appears deformed, but similar to **C. lobatulus**.

Cibicides malloryi Matsunaga (1963, P. 116, pl. 51, figures 7 and 8). 4.66. Ventral view, 22.5x (LD = .57 millimeters). 4.67. Dorsal view, 22.5x (LD = .57 millimeters).
Photograph of holotype (no number) in Tohoku University collections. This is not similar to **C. lobatulus,** but may be close to **C. mundulus** (Brady et al. 1890). However, this specimen has a sugary outside texture, which is probably a post-mortem feature.

Cibicides (?) omurai Asano and Inomata (in Asano 1952, p. 17, figures 97-99). 4.68. Dorsal view, 13.5x (LD = .74 millimeters). 4.69. Ventral view, 13.5x (LD = .74 millimeters). Photographs of holotype (#75254) in Tohoku University collections. It is easy to see why Asano and Inomata had a questionable generic designation, but the species is distinct. Takayanagi feels this species may have some relationship to the genus **Parrelloides**.

Cibicides yoitaensis Matsunaga (1963, p. 117, pl. 52, figure 3a-3c). 4.70. Ventral view, 22.5x (LD = .71 millimeters). 4.71. Dorsal view, 22.5x (LD = .71 millimeters). Photographs of the holotype (#85381) in the Tohoku University collections. This specimen is similar to **C. malloryi** (Figures 4.66 and 4.67).

Cribroelphidium aomoriense Asano (1950c, p. 11, figures 60 and 61). 4.72. Side view, 13.5x (LD = 1.26 millimeters). 4.73. Edge view showing aperture, 13.5x (LD = 1.18millimeters).
Photographs of holotype? (not labeled as holotype, but numbered #66185) in Tohoku University collections. This very badly etched specimen could be any one of a number of elphidiid species and therefore could not be designated as a new species.

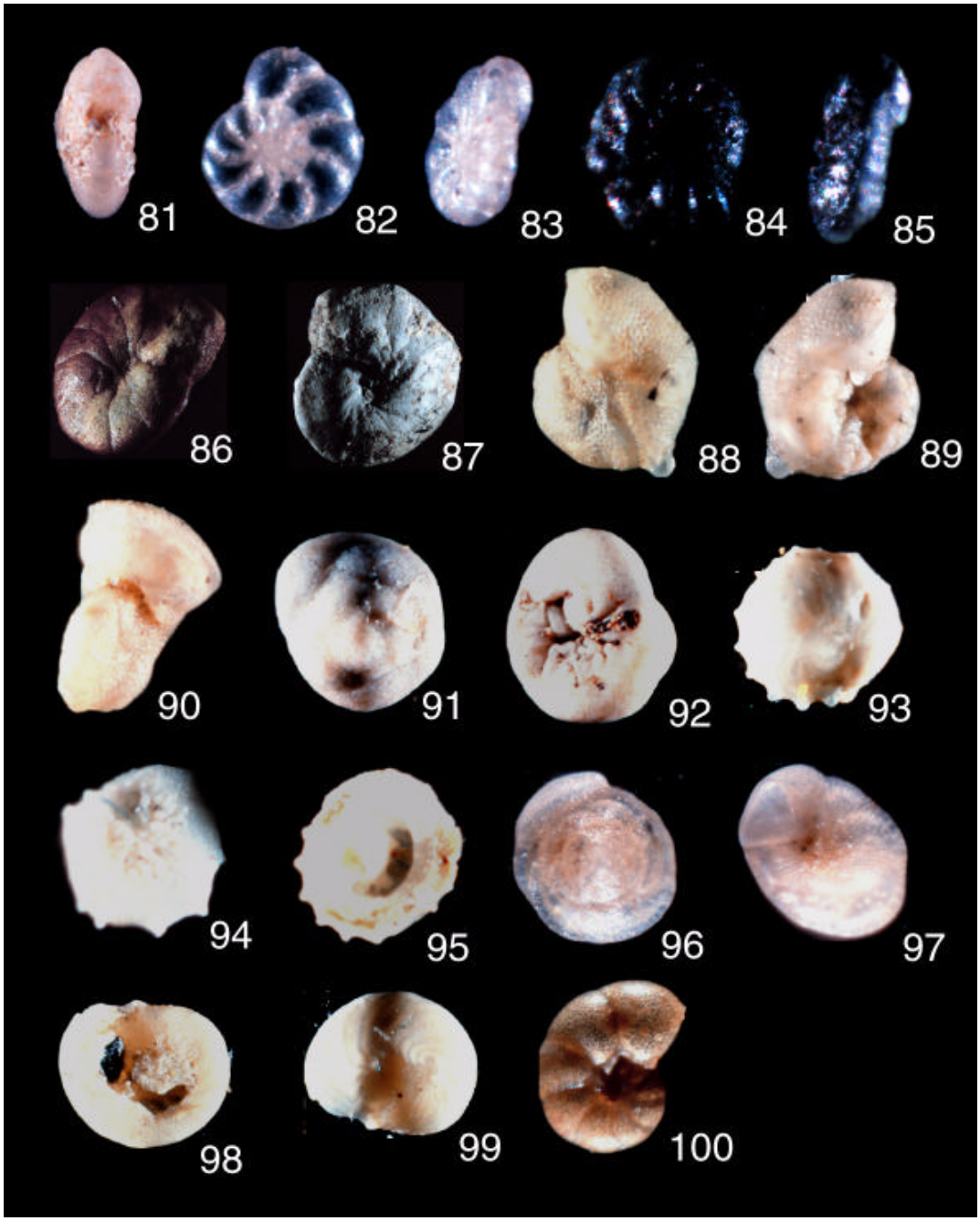
Cribroelphidium cribrojenseni Matsunaga (1963, p. 108, pl. 35, figure 11a-11b). 4.74. Side view, 13.5x (LD = 1.11 millimeters). 4.75. Edge view showing aperture, 13.5x (LD = 1.11 millimeters). Photographs of holotype (#85182) in Tohoku University collections. This species is very similar to the original **Polystella jenseni** Cushman (1924) that itself was put into synonymy with **Elphidium fichtellianum** (d'Orbigny 1846) by Hayward et al. (1997).

Cribroelphidium imanishii Asano (1953b, p. 52, figure 11a-11b). 4.76. Side view, 13.5x (LD = 1.18 millimeters). 4.77. Edge view showing aperture, 13.5x (LD = 1.18 millimeters). Photographs of holotype (#75287) in Tohoku University collections. This species, similar to **C. aomoriense** (Figures 72 and 73), is badly etched, but is probably not a distinct species.

Cribroelphidium kannonjiense Matsunaga (1963, p. 108, pl. 35 figure 12a-12b). 4.78. Side view, 13.5x (LD = 1.33 millimeters). 4.79. Edge view showing aperture, 13.5x (LD = 1.26 millimeters). Photographs of holotype (#85184) in the Tohoku University collections. This type is broken, but it is believed that this species is probably one of the **Elphidium excavatum** (Terquem 1876) group, not a distinct species.

Cribroelphidium nishiyamaense Matsunaga (1963, pl. 35, figure 13a-13b). 4.80. Side view, 13.5x (LD = 1.41 millimeters). Photographs of the holotype (#85185) in the Tohoku University collections. Although this specimen is badly broken and etched, it is probably part of the **E. excavatum** group (forma **selseyensis** Heron-Allen and Earland 1911). (See also 5.81.)

Figure 5.81-100. **Cribroelphidium nishiyamaense** Matsunaga 5.81: edge apertural view, 13.5x (LD = 1.33 millimeters). **Cribrononion miyakoense** Ujiie and Kusukawa 5.82: side view, 45x (LD = .38 millimeters). 5.83: edge apertural view, 45x (LD = .38 millimeters). **Cribrononion multicameratum** Ujiie 5.84: side view, 45x (LD = .29 millimeters). 5.85: edge apertural view, 45x (LD = .31 millimeters). **Cyclammina ezoensis** Asano 5.86: slanted side view, 7x (LD = 2.86 millimeters). **Cyclammina japonica** Asano 5.87: side view, 3x (LD = 6.67 millimeters). **Discanomalina japonica** Asano 5.88: side view, 13.5x (LD = 1.18 millimeters). 5.89: opposite side view, 13.5x (LD = 1.18 millimeters). 5.90: edge view, 13.5x (LD = 1.04 millimeters). **Discopulvinulina hofkeri** Asano 5.91: dorsal view, 13.5x (LD = 1.33 millimeters). 5.92: ventral view, 13.5x (LD = 1.33 millimeters). **Discorbis nakamurai** Asano 5.93: dorsal view of first specimen, 30x (LD = .63 millimeters). 5.94: ventral view of first specimen, 30x (LD = .50 millimeters). 5.95: ventral view of second specimen. 30x (LD = .63 millimeters). **Discorbis ozawai** Asano 5.96: dorsal view, 25x (LD = .80 millimeters). 5.97: ventral view, 25x (LD = .80 millimeters). **Discorbis subopercularis** Asano 5.98: ventral view, 13.5x (LD = 1.63 millimeters). 5.99: dorsal view, 13.5x (LD = 1.70 millimeters). **Echigoina hataii** Matsunaga 5.100: side view, 45x (LD = .56 millimeters).



5.81. Edge view showing aperture, 13.5x (LD = 1.33 millimeters) (continued from 5.80).

Cribrononion miyakoens Ujiie and Kusukawa (1969, p. 766, pl. 1, figures 3-7). 5.82. Side view, 45x (LD = .38 millimeters). 5.83. Edge view showing aperture, 45x (LD = .38 millimeters). Photographs of holotype (#244, 245) in the Tokyo National Museum. This species is identical to **Elphidium poeyanum** (d'Orbigny 1839) and therefore a junior synonym of that species.

Cribrononion multicameratum Ujiie (1977, p. 96, pl. 19, figures 1-3, pl. 20, figures 4 and 5).
5.84. Side view, 45x (LD = .29 millimeters). 5.85. Edge view showing aperture 45x (LD = .31 millimeters). Photographs of holotype (#973-975) in the Tokyo National Museum. These photographs turned out poorly even after several retakes because the specimens were stained. The color figure in this case is quite good, but it was impossible to get a good electronic scan for the plate here. The specimen appears to be part of the **E. excavatum** group, although it is difficult to say which forma it is.

Cyclammina ezoensis Asano (1951b, p. 5, figures 16 and 17). 5.86. Slanted side view, 7x (LD = 2.86 millimeters). Photograph of hypotype (holotype was broken during photography, #67075) in the Tohoku University collections. This species is identical to **C. cancellata** (Brady 1879) and hence is a junior synonym of that species.

Cyclammina japonica Asano (1950d, p.78, pl. 11, figures 3-8). 5.87. Side view, 3x (LD = 6.67 millimeters). Photograph of holotype (#66193) in the Tohoku University collections. This species is also a junior synonym to **C. cancellata**. No edge view is shown, but it is identical to **C. cancellata.**

Discanomalina japonica Asano (1951a, p. 13, figures 3-5). 5.88. Side view, 13.5x (LD = 1.18 millimeters). 5.89. Opposite side view, 13.5x (LD = 1.18 millimeters). 5.90. Edge view, 13.5x (LD = 1.04 millimeters). Photographs of holotype (#67129) in Tohoku University collections. Although this species has been shown already to be the junior synonym of **D. semipunctata** (Bailey 1851) by Medioli and Scott (1978), it is still the type species for the genus. It is an important forma in the lineage of **semipunctata** because it represents the extreme end member of the attached forms.

Discopulvinulina hofkeri Asano (1951c, p. 5, figures 30 and 31). 5.91. Dorsal view, 13.5x (LD = 1.33 millimeters). 5.92. Ventral view, 13.5x (LD = 1.33 millimeters). Photographs of holotype (#67172) in the Tohoku University collections. This looks like a distinct species.

Discorbis nakamurai Asano (1951c, p. 2, figures 8-10). 5.93. Dorsal view of first specimen, 30x (LD = .63 millimeters). 5.94. Ventral view of first specimen, 30x (LD = .50 millimeters). 5.95. Ventral view of second specimen. 30x (LD = .63 millimeters). All photographs from specimens on the holotype slide (#67164) in the Tohoku University collections. This was a very interesting group because it had three specimens in the holotype slide: two specimens joined in plastogamy (which was broken apart; Figures 93 and 94); the other is a single specimen where only the ventral side was photographed (Figure 5.95).

Discorbis ozawai Asano (1951c, p. 3, figures 14-16). 5.96. Dorsal view, 25x (LD = .80 millimeters). 5.97. Ventral view, 25x (LD = .80 millimeters). Photographs of holotype (#67163) in the Tohoku University collections. This appears to be a distinct species.

Discorbis subopercularis Asano (1951c p. 3, figures 17-19). 5.98. Ventral view, 13.5x (LD = 1.63 millimeters). 5.99. Dorsal view, 13.5x (LD = 1.70 millimeters). Photographs of holotype (#67167) in the Tohoku University collections. This looks like a distinct species. This particular specimen is damaged on the ventral side; however, the radial structure on the ventral chambers can still be seen, which may give the species affinities to genus **Glabratella.**

Echigoina hataii Matsunaga (1963, p. 115, pl. 50, figure 4a-4b). 5.100. Side view, 45x (LD = .56 millimeters). Photographs of holotype (#85368) in the Tohoku University collections. This species may be distinct, but the genus is probably **Astrononion** and not the genus described by Matsunaga. Holotype of the genus does fit with the type description, except for the trochospiral chamber arrangement. Another species in the same paper placed in this genus (for which Scott did not find the specimen, **E. furutsuensis**) does show some trace of a trochospiral arrangement. This species was so rare in the type material that we are treating them as aberrant specimens of the genus **Astrononion**. However, the description of **Astrononion** does not mention any trace of trochospiral arrangement and emendation of the genus would require finding that characteristic in the type species of **Astrononion**. (See also 6.101.)

Figure 6.101-120. Echigoina hataii Matsunaga 6.101: tilted edge view, 45x (LD = .49 millimeters). **Eggerella matsunoi** Takayanagi, n. sp. 6.102: side apertural view, 45x (LD = .67 millimeters). 6.103: side view, 45x (LD = .67 millimeters). 6.104: side apertural view, 45x (LD = .67 millimeters). **Elphidiella nagaoi** Asano 6.105: side view , 10x (LD = 2.00 millimeters). 6.106: slanted edge view, 10x (LD = 2.00 millimeters). **Elphidium asanoi** Matsunaga 6.107: side view, 45x (LD = .47 millimeters). 6.108: edge apertural view, 45x (LD = .47 millimeters). **Elphidium advena** Cushman **gorokuense** Takayanagi 6.109: side view, 13.5x (LD = .89 millimeters). 6.110: edge apertural view, 13.5x (LD = .89 millimeters). **Elphidium etigoense** Husezima and Maruhasi 6.111: side view, 37.5x (LD = .59 millimeters). 6.112: apertural edge view, 37.5x (LD = .59 millimeters). **Elphidium ezoense** Asano 6.113: side view, 7.5x (LD = 3.06 millimeters). 6.114: slanted side view, 7.5x (LD = 2.93 millimeters). **Elphidium hanzawai** Asano 6.115: side view, 13.5x (LD = 1.26 millimeters). 6.116: edge view, 13.5x (LD = 1.26 millimeters). **Elphidium hokkaidoense** Asano 6.117: side view, 37.5x (LD = .53 millimeters). 6.118: edge view, 37.5x (LD = .53 millimeters). **Elphidium kusiroense** Asano 6.119: side view, 30x (LD = .73 millimeters). 6:120: edge view, 30x (LD = .67 millimeters).

6.101. Tilted edge view, 45x (LD = .49 millimeters) (continued from 6.100).

Eggerella matsunoi Takayanagi n. sp. 6.102. Side view showing aperture, 45x (LD = .67 millimeters). 6.103. Side view, 45x (LD = .67 millimeters). 6.104. Side view showing aperture, 45x (LD = .67 millimeters).
Holotype: Specimen number 75023 in Tohoku University collections.
Type locality: Lat. 44º, 41' 54.6"N, long. 141º, 59' 03.2". Location no. EN-84, cliff of the upper stream of the Rubeshube River, a branch of the Ebetsu River, about 6,600m ENE of the Chuo Post office, Embetsu-machi, Teshio-gun, Teshio Province, Hokkaido.
Type formation: East Chikubetsu Formation.
Type level: Miocene.
Description: Test free, small elongate, moderately tapering in early portion, nearly cylindrical in later triserial portion, frequently compressed; chambers numerous, low and broad, increasing rather rapidly in size in early portion with four to five chambers to a whorl, later becoming inflated and increasing gradually in size as added; sutures distinct and depressed; wall finely agglutinated, with much cement, surface smoothly finished; aperture an indistinct low arch at the base of the last -formed chamber; white in color.
Remarks: This species is similar to **Eggerella karamatensis** (Brönnimann 1953) from the Oligo-Miocene of Trinidad, but is easily distinguished from that species by a more elongate test.
Specific name is given in honor of Dr. Kyuya Matsuno, formerly of the Geological Survey of Japan.

Elphidiella nagaoi Asano (1938a, p. 590, pl. 14 (3), figure 8a-8b). 6.105. Side view, 10x (LD = 2.00 millimeters). 6.106. Slanted edge view, 10x (LD = 2.00 millimeters). Photograph of holotype (#21421) in the Tohoku University collections. This species is identical in every respect to **E. arctica** (Parker and Jones **in** Brady 1864), including characters such as a large test, thick shell, and the typical double rows of sutural pores with associated striations. It is therefore a junior synonym of the Parker and Jones species.

Elphidium asanoi Matsunaga (1963, p. 109, pl. 36, figure 6a-6b). 6.107. Side view, 45x (LD = .47 millimeters). 6.108. Edge apertural view, 45x (LD = .47 millimeters). Photographs of holotype (#85190) in the Tohoku University collections. This specimen is in poor condition, but could be a distinct species. It does not appear to be a member of the **E. excavatum** group.

Elphidium advena Cushman **gorokuense** Takayanagi (1950, p. 27, figure 4). 6.109. Side view, 13.5x (LD = .89 millimeters). 6.110. Edge view showing aperture, 13.5x (LD = .89 millimeters). Photographs of holotype (#66105) in the Tohoku University collections. According to Scott, this species is an ecophenotype of **E. advena** (Cushman 1921), not a subspecies.

Elphidium etigoense Husezima and Maruhasi (1944, p. 392, pl. 34, figure 1a-1b. 6.111. Side view, 37.5x (LD = .59 millimeters). 6.112. Edge view showing aperture, 37.5x (LD = .59 millimeters).
Photographs of hypotype (no number) in the Tohoku University collections. This particular specimen is badly etched, but we agree with a later paper by Ishiwada (1964) that is referable to **E. bartletti** Cushman (1933) and is not a distinct species.

Elphidium ezoense Asano (1937a, p. 787. pl. 24 (12), figures 1 and 2, text figure 1a-1b). 6.113. Side view, 7.5x (LD = 3.06 millimeters). 6.114. Slanted side view, 7.5x (LD = 2.93 millimeters). Photographs from holotype slide (#21433) in Tohoku University collections with about 50 specimens. None of the specimens was designated as the holotype, so a representative specimen was selected. This could be a distinct species, but Scott thought it very similar to **E. galvestonense** (Kornfeld 1931), for which this would be a junior synonym. However, unlike **galvestonense,** this is a cold water species**.** Takayanagi believes this species may be closer to **E. oregonense** (Cushman and Grant 1927), which is a colder water species. This hypothesis is probably correct because **E. ezoense** has cribrate apertures similar to those of **E. oregonense.** Asano (1950a) assigned this species to the genus **Cribroelphidium.**

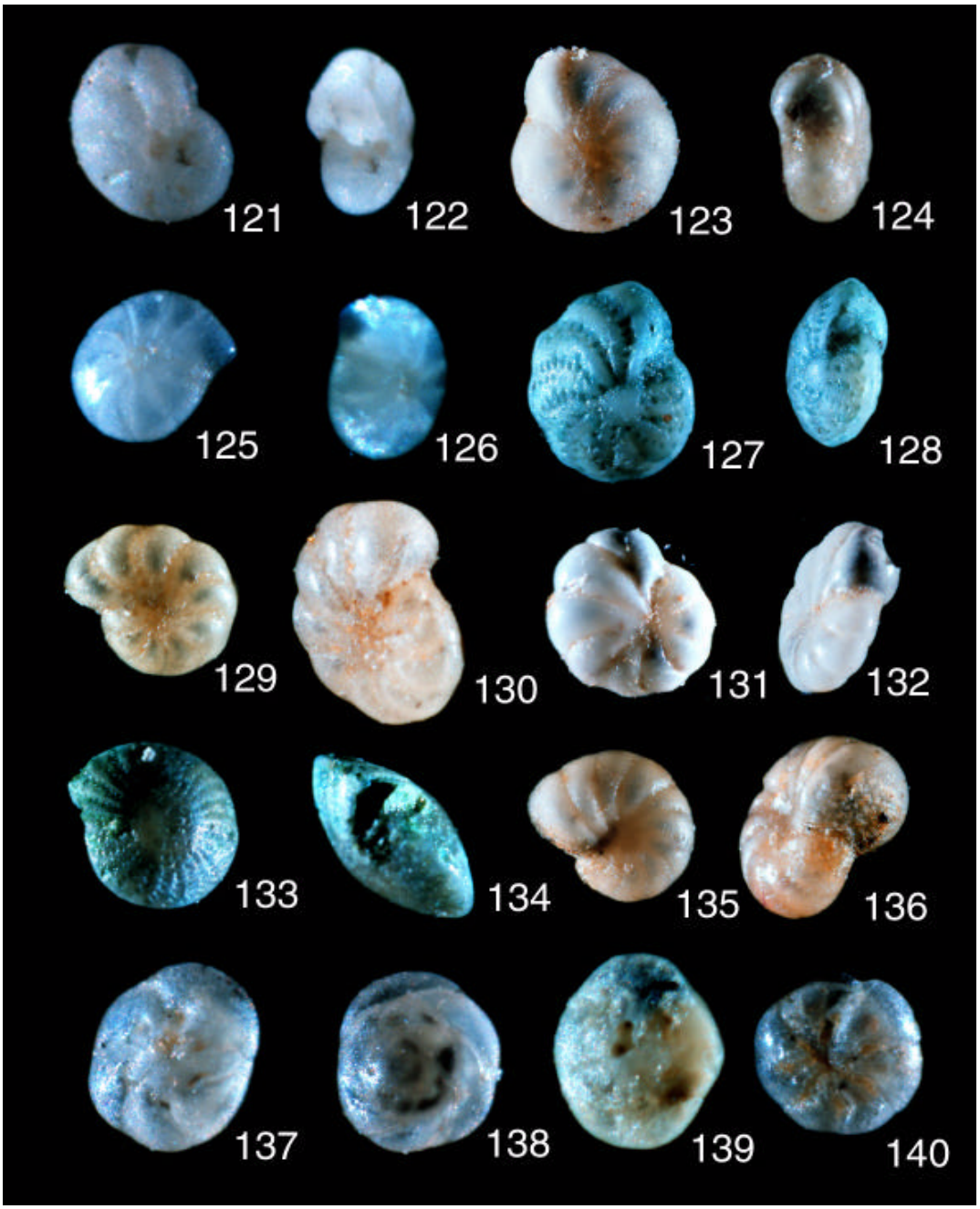
Elphidium hanzawai Asano (1939, p. 426, text figures 3, 4, and 6). 6.115. Side view, 13.5x (LD = 1.26 millimeters). 6.116. Edge view, 13.5x (LD = 1.26 millimeters). Photographs of holotype (#62910) in the Tohoku University collections. This is another junior synonym of Cushman's 1921 species, **E. advena.**

Elphidium hokkaidoense Asano (1950a, p. 8, figures 44 and 45). 6.117. Side view, 37.5x (LD = .53 millimeters). 6.118. Edge view, 37.5x (LD = .53 millimeters). Photographs of paratype (#66178) in the

Tohoku University collections. This poorly preserved specimen could be a variant of **Elphidium advena.**

Elphidium kusiroense Asano (1938a, p. 590, pl. 14 (3), figure 2). 6.119. Side view, 30x (LD = .73 millimeters). 6.120. Edge view, 30x (LD = .67 millimeters). Photographs of holotype (#21420) in the Tohoku University collections. This species is close to **E. margaritaceum** Cushman (1930), but this specimen has a large umbilical boss that is not present in **margaritaceum** while having the same sugary texture common to **E. margaritaceum.**

Figure 7.121-140. Elphidium matsukawauraense Takayanagi 7.121: side view, 45x (LD = .24 millimeters). 7.122: edge apertural view, 45x (LD = .24? millimeters). **Elphidium sendaiense** Takayanagi 7.123: side view,13.5x (LD = 1.33 millimeters). 7.124: edge apertural view, 13.5x (LD = .89 millimeters). **Elphidium somaense** Takayanagi 7.125: side view, 45x (LD = .24 millimeters). 7.126: edge view, 45x (LD = .24 millimeters). **Elphidium subcrispum** Nakamura 7.127: side view, 13.5x (LD = .89 millimeters). 7.128: edge view, 13.5x (LD = .96 millimeters). **Elphidium subgranulosum** Asano 7.129: side view, 45x (LD = .47 millimeters). 7.130: slanted edge, 45x (LD = .44 millimeters). **Elphidium subincertum** Asano 7.131: side view, 13.5x (LD = 1.18 millimeters). 7.132: edge view, 13.5x (LD = 1.18 millimeters). **Elphidium taiwanum** Nakamura 7.133: side view, 13.5x (LD = 1.11 millimeters). 7.134: edge view, 13.5x (LD = 1.03 millimeters). **Elphidium yabei** Asano 7.135: side view, 13.5x (LD = 1.63 millimeters). 7.136: edge apertural view, 13.5x (LD = 2.80 millimeters). **Epistomaria (Epistomariella) miurensis** Kuwano 7.137: ventral view, 7.5x (LD = 2.00 millimeters). 7.138: dorsal view, 7.5x (LD = 2.00 millimeters). 7.139: edge view, 7.5x (LD = 2.27 millimeters). **Epistomaria (Epistomariella) nakazatoensis** Kuwano 7.140: ventral view, 45x (LD = .38 millimeters).



Elphidium matsukawauraense Takayanagi (1955, p. 51, figure 27a-27 b). 7.121. Side view, 45x (LD = .24 millimeters). 7.122. Edge view showing aperture, 45x (LD = .24 millimeters). Photographs of holotype (#67150) in the Tohoku University collections. This specimen is badly etched and could be one of several species. We suspect that it is a distinct species, but need better preserved specimens to verify its species characteristics.

Elphidium sendaiense Takayanagi (1950, p. 26, figure 3). 7.123. Side view, 13.5x (LD = 1.33 millimeters). 7.124. Edge view showing aperture, 13.5x (LD = .89 millimeters). Photograph of holotype (#66104) in the Tohoku University collections. Similar to **E. bartletti,** especially in the absence of areal apertures on the last chamber face. However, the specimen is etched, so areal apertures may be obscured.

Elphidium somaense Takayanagi (1955, p. 52, figure 28a-28b). 7.125. Side view, 45x (LD = .24 millimeters). 7.126. Edge view, 45x (LD = .24 millimeters). Photographs of holotype (#67151) in the Tohoku University collections. This is a very interesting species because there is nothing like it in the Atlantic. It does not appear to belong to the genus **Elphidium**; perhaps it is **Nonion** or other allied genera, but it is a distinct species.

Elphidium subcrispum Nakamura (1937, p. 139, pl. 11, figure 8a-8b). 7.127. Side view, 13.5x (LD = .89 millimeters). 7.128. Edge view, 13.5x (LD = .96 millimeters). Photographs of holotype (no number) in the Tohoku University collections. This species certainly is different from the original **E. crispum** (Linne 1758) on the basis of a large umbilical boss.

Elphidium subgranulosum Asano (1938a, p. 586, pl. 14 (3), figure 4a-4b). 7.129. Side view, 45x (LD = .47 millimeters). 7.130. Slanted edge view, 45x (LD = .44 millimeters). Photographs of the holotype (#21418) from the Tohoku University collections. This badly etched specimen belongs with **E. poeyanum** (d'Orbigny 1839) and is not a distinct species.

Elphidium subincertum Asano (1950a, p. 10, figures 56 and 57). 7.131. Side view, 13.5x (LD = 1.18 millimeters). 7.132. Edge view, 13.5x (LD = 1.18 millimeters). Photographs of holotype (unnumbered) in the Tohoku University collections. This species is almost certainly the same as the original **E. incertum** (Williamson 1858), complete with the indistinct sutural pores of the original species.

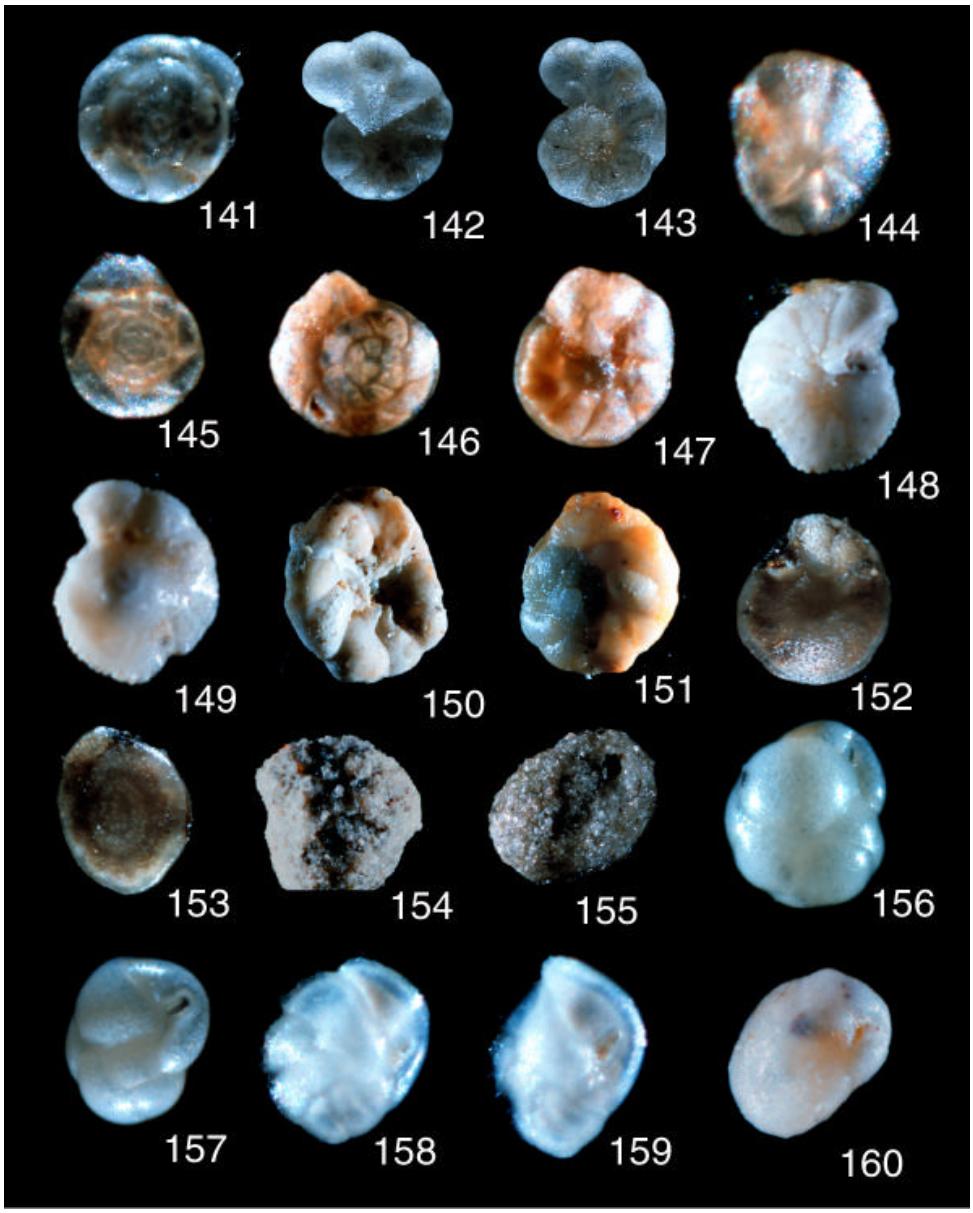
Elphidium taiwanum Nakamura (1937, p. 139, pl. 11, figure 9a-9b). 7.133. Side view, 13.5x (LD = 1.11 millimeters). 7.134. Edge view, 13.5x (LD = 1.03 millimeters). Photographs of holotype (no number) in the Tohoku University collections. This large tropical form may actually be a **Cellanthus** species, but it looks like a distinct species nonetheless.

Elphidium yabei Asano (1938a, p. 589, pl. 14 (3), figures 9a-9b and 10a-10b). 7.135. Side view, 13.5x (LD = 1.63 millimeters). 7.136. Edge view showing aperture, 13.5x (LD = 2.80 millimeters). Photographs of holotype (#21419) in the Tohoku University collections. This species appears very similar to **E. bartletti** Cushman (1933), but could be a distinct species.

Epistomaria (Epistomariella) miurensis Kuwano (1950, p. 315 and 316, figures 3 and 10). 7.137. Ventral view, 7.5x (LD = 2.00 millimeters). 7.138. Dorsal view, 7.5x (LD = 2.00 millimeters). 7.139. Edge view, 7.5x (LD = 2.27 millimeters). Photographs of paratype (no number) in the Tokyo National Museum. This species was subsequently called **Pseudoeponides japonica** by Uchio **in** Asano (1951c). This appears to be a distinct species and takes precedence over Uchio's name.

Epistomaria (Epistomariella) nakazatoensis Kuwano (1950, p. 316, figures 4 and 11). 7.140. Ventral view, 45x (LD = .38 millimeters). Photographs of ideotype (no number) in Tokyo National Museum. This species was also placed into **Pseudoeponides** by Asano (1951c). This species could be a variant within the **Ammonia beccarii** (Linne 1758) group, but has supplementary apertures on the spiral side similar to the genus **Helenina**. (See also 8.141.)

Figure 8.141-160. Epistomaria (Epistomariella) nakazatoensis Kuwano 8.141: dorsal view, 45x (LD = .42 millimeters). **Epistomaria yabei** Asano 8.142: ventral view, 10x (LD = 2.20 millimeters). 8.143: dorsal view, 10x (LD = 2.20 millimeters). **Epistominella takayanagii** Iwasa 8.144: ventral view, 45x (LD = .20 millimeters). 8.145: dorsal view, 45x (LD = .45 millimeters). **Eponides hatakeyamai** Iwasa and Kikuchi 8.146: dorsal view, 45x (LD = .38 millimeters). 8.147: ventral view, 45x (LD = .38 millimeters). **Eponides orientalis** Asano 8.148: ventral view, 13.5x (LD = 1.18 millimeters). 8.149: dorsal view, 13.5x (LD = 1.18 millimeters). **Eponides sasai** Asano 8.150: ventral view, 3x (LD = 5.33 millimeters). 8.151: dorsal view, 3x (LD = 5.67 millimeters). **Eponides subpraecinctus** Asano 8.152: ventral view, 13.5x (LD = 1.48 millimeters). 8.153: dorsal view, 13.5x (LD = 1.48 millimeters). **Flintina subglobosa** Takayanagi 8.154: side? view, 13.5x (LD = 1.56 millimeters). 8.155: aperture view, 13.5x (LD = 1.48 millimeters). **Globocassidulina bisecta** Nomura 8.156: side aperture view, 45x (LD = .38 millimeters). 8.157: aperture up view, 45x (LD = .38 millimeters). **Globocassidulina crenulata** Nomura 8.158: side aperture view, 45x (LD = .33 millimeters). 8.159: aperture up view, 45x (LD = .35 millimeters). **Globocassidulina mucronata** Nomura 8.160: side apertural view, 45x (LD = .35 millimeters).



8.141. Dorsal view, 45x (LD = .42 millimeters) (continued from 7.140).

Epistomaria yabei Asano (1936a, p. 945, pl. 52 (18), figure 1a-1c). 8.142. Ventral view, 10x (LD = 2.20 millimeters). 8.143. Dorsal view, 10x (LD = 2.20 millimeters). Photographs of holotype (#21392) in the Tohoku University collections. This is one of the most beautiful photographs taken in this collection. This specimen appears to be a distinct species.

Epistominella takayanagii Iwasa (1955, p. 17, text figure 4a-4c). 8.144. Photograph of a ventral view, 45x (LD = .20 millimeters). 8.145. Dorsal view, 45x (LD = .45 millimeters). Photographs of holotype (#65504) in the Tohoku University collections. This is an important species in some Pleistocene deposits from the eastern North American continental margin where it sometimes composes up to 90% of a fauna with high abundances (Scott 1987). It is similar to **E. sandiegoensis** Uchio (1960) from offshore California, but this name takes precedence. However, there is another species illustrated later in this paper (**Pseudoparella tamana** Kuwano) that is also very similar, but it was very badly preserved in Kuwano's collection. Hasegawa has seen other specimens of this species; it differs from **E. takayanagi** in having a wider periphery and fewer chambers in the last whorl.

Eponides hatakeyamai Iwasa and Kikuchi (1954, p. 192, text figure 6a-6c). 8.146. Dorsal view, 45x (LD = .38 millimeters). 8.147. Ventral view, 45x (LD = .38 millimeters). Photographs of holotype (#65521) in the Tohoku University collections. As pointed out in Takayanagi and Hasegawa (1987), this species belongs to the genus **Gavelinopsis,** but is a distinct species.

Eponides orientalis Asano (1937b, p. 117, pl. 16, figure 8a-8c). 8.148. Ventral view, 13.5x (LD = 1.18 millimeters). 8.149. Dorsal view, 13.5x (LD = 1.18 millimeters). Photographs of hypotype (#67186) in the Tohoku University collections. The slide is listed as the holotype for **E. orientalis** (Asano 1951a), but the holotype and the 1951 species are invalid because the 1951 species is a primary junior homonym of the 1937 species and the “holotype” specimen becomes a hypotype. The original holotype is probably IGPS# 21394 from Shiogama Bay in the southern inlet of Matsushima Bay east of Sendai. The hypotype designated in 1951 is from the Tertiary of the Muira Peninsula. This is possibly a distinct species, but the specimen itself is in very bad condition; this is especially evident when it is viewed dorsally and it is difficult to see the suture lines.

Eponides sasai Asano (1938b, p. 94, pl. 10, figures 2 and 3). 8.150. Ventral view, 3x (LD = 5.33 millimeters). 8.151. Dorsal view, 3x (LD = 5.67 millimeters). Photographs of holotype (#21451) in the Tohoku University collections. This species was placed into the genus **Discorbis** by Takayanagi and Hasegawa (1987). It appears to be a distinct species.

Eponides subpraecinctus Asano (1951c, p. 12, figures 88-90). 8.152. Ventral view, 13.5x (LD = 1.48 millimeters). 8.153. Dorsal view, 13.5x (LD = 1.48 millimeters). Photographs of holotype (#67189) in the Tohoku University collections. This species was subsequently placed in the genus **Helerolepa** by Takayanagi and Hasegawa (1987).

Flintina subglobosa Takayanagi (1953, p. 27, pl. 4, figure 2a-2c). 8.154. Side? view, 13.5x (LD = 1.56 millimeters). 8.155. Apertural view, 13.5x (LD = 1.48 millimeters). Photographs of holotype (#67135) in the Tohoku University collections. There is a question mark by the side view because we cannot really be sure this is a side view. There are no visible chambers on the exterior, but from the apertural view it is clear that this is not a uniloc-ular form. In the original description of **Flintina** (from Loeblich and Tappan 1964, 1988), this genus is described as porcelaneous, not agglutinated, so the specimens shown here are clearly not in the correct genus. However, without breaking open the type specimens to determine whether they are planispiral, we cannot determine in what genus the species should be placed.

Globocassidulina bisecta Nomura (1983a, p. 73, pl. 2, figures 2 and 3; pl. 2, figure 3a-c; pl. 14, figures 8-12; pl. 15, figures 1-5). 8.156. Side view showing aperture, 45x (LD = .38 millimeters). 8.157. Apertural view, 45x.
Photographs of holotype (#97220) in the Tohoku University collections. This species is similar to **G. subglobosa** (Brady 1881), but the aperture bisects into two slits, one running perpendicular to the coiling direction and one up against the whorl in the last chamber, which Nomura (1983a) showed.

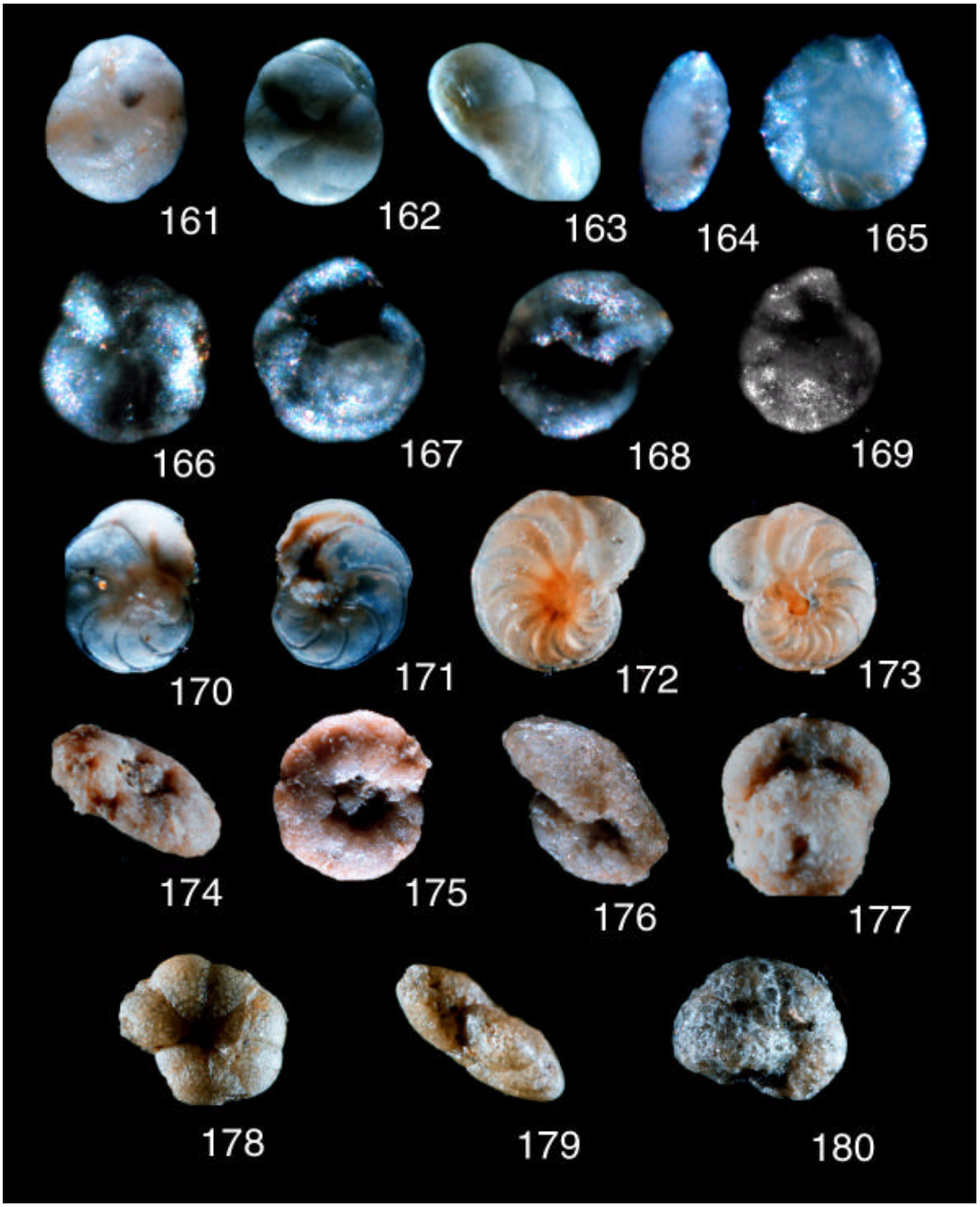
Globocassidulina crenulata Nomura (1983a, p. 60, pl. 1, figures 9 and 10; pl. 19, figures 7-9 and 11). 8.158. Side view showing aperture, 45x (LD = .33 millimeters). 8.159. Apertural view, 45x (LD = .35 millimeters). Photographs of holotype (#97191) in the Tohoku University collections. This species is very similar to **Cassidulina yabei serrata** Matsunaga, described earlier here. As with the **serrata,** there is a serrated edge and the overall form is similar to the **Islandiella** species so common in the North Atlantic; we put this species into Matsu-

naga's species, which takes precedence over this name. Hence, this species becomes **Cassidulina (Islandiella?) yabei serrata.**

Globocassidulina mucronata Nomura (1983a, p. 63, pl. 1, figures 12 and 13; pl. 13, figures 2-4).

8.160. Side view showing aperture, 45x (LD = .35 millimeters). Photographs of paratype (#97195) in the Tohoku University collections. This specimen is poorly preserved, but Scott assigns this to **G. subglobosa** . (See also 9.161.)

Figure 9.161-180. Globocassidulina mucronata Nomura 9.161: aperture up view, 45x (LD = .35 millimeters). **Globocassidulina neobrocha** Nomura 9.162: side apertural view, 45x (LD = .49 millimeters). 9.163: edge apertural view, 45x (LD = .49 millimeters). **Globocassidulina venustas** Nomura 9.164: edge apertural view, 45x (LD = .20 millimeters). 9.165: side view; 45x (LD = .20 millimeters). **Gyroidina nipponica** Ishizaki **exigua** Ujiie 9.166: ventral view, 45x (LD = .20 millimeters). 9.167: dorsal view, 45x (LD = .20 millimeters). **Gyroidina suturalis** Ujiie 9.168: ventral view, 45x (LD = .31 millimeters). 9.169: dorsal view, 45x (LD = .31 millimeters). **Hanzawaia hamadaensis** Asano 9.170: dorsal view, 37.5x (LD = .61 millimeters). 9.171: ventral view, 37.5x (LD = .61 millimeters). **Hanzawaia tagaensis** Asano 9.172: dorsal view, 13.5x (LD = 1.11 millimeters). 9.173: ventral view, 13.5x (LD = 1.11 millimeters). **Haplophragmoides hatai** Takayanagi, n. sp. 9.174: edge apertural view, 13.5x (LD = 1.70 millimeters). 9.175: side view, 13.5x (LD = 1.63 millimeters). **Haplophragmoides nishikizawensis** Takayanagi, n. sp. 9.176: side view, 13.5x (LD = 1.48 millimeters). 9.177: edge apertural views, 13.5x (LD = 1.41 millimeters). **Haplophragmoides sintikuensis** Nakamura 9.178: side view, 7.5x (LD = 2.80 millimeters). 9.179: edge aperture view, 7.5x (LD = 2.80 millimeters). **Haplophragmoides taiwanensis** Nakamura 9.180: side view, 13.5x.



9.161. Apertural view, 45x (LD = .35 millimeters) (continued from 8.160).

Globocassidulina neobrocha Nomura (1983a, p. 67, pl. 1, figure 16a-c; pl. 19, figures 3-6). 9.162. Side view showing aperture, 45x (LD = .49 millimeters). 9.163. Edge view showing aperture, 45x (LD = .49 millimeters). Photographs of holotype (#97206) in the Tohoku University collections. These specimens appear appear to be a distinct species.

Globocassidulina venustas Nomura (1983a, p. 60, pl. 1, figures 7a-7c and 8; pl. 14, figures 4-7). 9.164. Edge view showing aperture, 45x (LD = .20 millimeters). 9.165. Side view; 45x (LD = .20 millimeters). Photographs of holotype (#97224) in the Tohoku University collections. This is a distinct species; it has an overall external outline similar to that of **Islandiella,** but it has an extra external coil not visible in **Islandiella.**

Gyroidina nipponica Ishizaki **exigua** Ujiie (1977, p. 99, pl. 17, figure 5). 9.166. Ventral view, 45x (LD = .20 millimeters). 9.167. Dorsal view, 45x (LD = .20 millimeters). Photographs of holotype (#983) in National Science Museum (Tokyo, Shinjuku branch). This subspecies does not appear to be a true **Gyroidina** because it lacks any umbilical cavity such as is seen in **G. soldani** (d'Orbigny 1826). Hasegawa placed this species into **Gyroidina umbonata** (Silvestri 1898), which was originally described as **Rotalia soldani** d'Orbigny var. **umbonata** Silvestri (1898).

Gyroidina suturalis Ujiie (1977, p. 98, pl. 14, figures 8 and 9). 9.168. Ventral view, 45x (LD = .31 millimeters). 9.169. Dorsal view, 45x (LD = .31 millimeters). Photographs of holotype (#984) in the National Science Museum (Tokyo, Shinjuku branch). This species is also a junior synonym of G**. soldanii**.

Hanzawaia hamadaensis Asano (1951a, p. 16, figures 21-23). 9.170. Dorsal view, 37.5x (LD = .61 millimeters). 9.171. Ventral view, 37.5x (LD = .61 millimeters). Photographs of holotype (#67118) in the Tohoku University collections. Specimen is broken but appears to be a distinct species.

Hanzawaia tagaensis Asano (1949, p. 430, figure 1, nos. 28-30; figure 2, nos. 31 and 32). 9.172. Dorsal view, 13.5x (LD = 1.11 millimeters). 9.173. Ventral view, 13.5x (LD = 1.11 millimeters). Photographs of holotype (#67047) in the Tohoku University collections. This is a very good specimen and looks like a distinct species.

Haplophragmoides hatai Takayanagi, n. sp.
9.174. Edge view showing aperture, 13.5x (LD = 1.70 millimeters). 9.175. Side view, 13.5x. (LD = 1.63 millimeters).
Holotype: Specimen number 75020 in the Tohoku University collections.
Type locality: Lat. 43º, 03' 24.6"N, Long. 141º, 54' 39.2"E. Locality no. YH-108, cliff of small tributary of the northern branch of the Anoro River, about 1,150 m south of Hinode Shrine, Hinode, Kuriyama-machi, Yubari-gun, Ishikari Province, Hokkaido.
Type formation: East Takinoue Formation
Type level: Miocene
Description: Test free, medium in size, planispiral, partially evolute, exposing earlier coils, umbilical region depressed, periphery subacute, somewhat lobulate in later chambers; plane of coiling of outer whorl, in adult, somewhat displaced from earlier portion, giving slightly asymmetric appearance to test; chambers slightly inflated, increasing very gradually in size as added, about 12 chambers in last whorl; sutures rather distinct, slightly depressed, straight or slightly curved; wall finely agglutinated with considerable cement, surface rather smoothly finished; aperture at base of apertural face of last formed chamber, but usually indistinct; color usually yellowish brown.
Greatest diameter of holotype is 1.07 mm, least is 0.91 mm; greatest thickness is 0.29 mm. Other specimens range in greatest diameter from 0.28-1.10 mm.

Remarks: This species is similar to **Haplophragmoides compressa** Leroy (1939) from the Miocene of Sumatra, but differs in possessing rather irregularly coiled whorls with subacute periphery and many more chambers. Specific name is given in honour of Dr. Mitsuo Hata, formerly of the Geological Survey of Japan. This species is unlike any ever seen in the Recent and almost appears in outline as a **Cyclammina.**

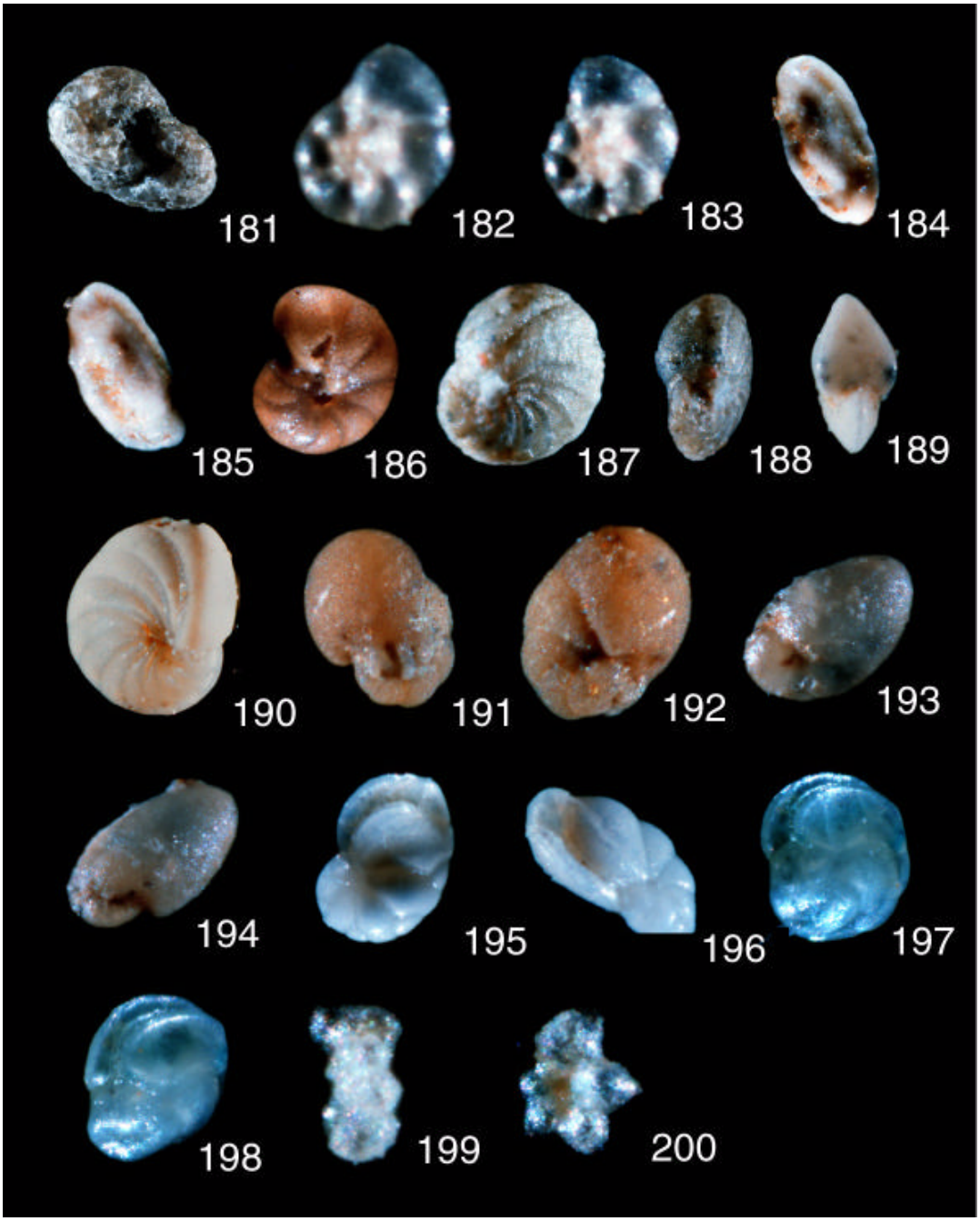
Haplophragmoides nishikizawensis Takayanagi, n. sp. 9.176. Side view, 13.5x (LD = 1.48 millimeters). 9.177. Edge view showing aperture, 13.5x.
Holotype: Specimen number 75021 in the Tohoku University collections.
Type locality: Lat. 43º, 00' 32.2"N, long. 141º, 57' 06.8"E. Location no. YH-132, cliff of a small tributary of the Orochinosawa, about 650 m SW of Nishikizawa Station of the Yubari Railway Line, Yubari City, Ishikari Province.
Type formation: East Takinoue Formation
Type level: Miocene **Description:** Test free, medium in size, globose, planispiral, involute, slightly umbilicate, periphery rounded, often distorted in various manners; chambers increasing in size gradually as added; about seven in last whorl; sutures nearly radial, usually not so distinct; wall moderately coarse, agglutinated, but surface rather smoothly finished with cement; aperture a narrow low slit at base of apertural face of last formed chamber; color mostly grayish white.

Remarks: Although this species is variously distorted, it resembles closely **Haplophragmoides proboscidiformis** Smith (1949) from the early Middle Miocene of Louisiana (USA). However, it differs from the latter species in a globose, larger test without an apertural lip.
At first this species appears similar to **Cribrostomoides subglobosus** (Sars 1872), but that species is not as deformed looking as this species, and unlike **C. subglobosus,** this species does not appear to have a cribrate aperture structure, but just a slit.

Haplophragmoides sintikuensis Nakamura (1937, p. 133, pl. 10, figure 2a and 2b). 9.178. Side view, 7.5x (LD = 2.80 millimeters). 9.179. Edge view showing aperture, 7.5x (LD = 2.80 millimeters).
Photographs of holotype (#60853) in the Tohoku University collections. This species was subsequently placed in the genus **Reticulophragmium** by Huang (1968). This may be a distinct species, but is similar to **H. hancocki** Cushman and McCulloch (1939) from nearshore areas off New England.

Haplophragmoides taiwanensis Nakamura (1937, p. 134, pl. 10, figure 3a and 3b). 9.180. Side view, 13.5x (LD = 1.85 millimeters).
Photographs of holotype (#60854) in the Tohoku University collections. This coarse-grained specimen is a distinct species. (See also 10.181.)

Figure 10.181-200. Haplophragmoides taiwanensis Nakamura 10.181: edge apertural view, 13.5x (LD = 1.85 millimeters). **Hyalinea inflata** Ujiie and Kusukawa 10.182: side view, 45x (LD = .38 millimeters). 10.183: ventral view, 45x (LD = .38 millimeters). **Miliammina echigoensis** Asano and Inomata **in** Asano 10.184: 4 chambered side up view, 45x (LD = .51 millimeters). 10.185: apertural end up, 45x (LD = .44 millimeters). **Nonion aimonoi** Matsunaga 10.186: side view, 45x (LD = .49 millimeters). **Nonion nagasawaense** Matsunaga 10.187: side view 13.5x (LD = 1.18 millimeters). 10.188: edge view, 13.5x (LD = 1.18 millimeters). **Nonion nakosoense** Asano 10.189: edge apertural view, 13.5x (LD = .67 millimeters). 10.190: side view, 13.5x (LD = .96 millimeters). **Nonionella hanzawai** Asano 10.191: slanted dorsal view, 13.5x (LD = .74 millimeters). 10.192: ventral view, 13.5x (LD = .67 millimeters). **Nonionella higashiyamaensis** Matsunaga 10.193: side view, 45x (LD = .47 millimeters). 10.194: edge apertural view, 45x (LD = .47 millimeters). **Paracassidulina nabetaensis** Nomura 10.195: side apertural view, 45x (LD = .58 millimeters). 10.196: edge apertural view, 45x (LD = .58 millimeters). **Paracassidulina quasicarinata** Nomura 10.197: side aperture view, 45x (LD = .35 millimeters). 10.198: slanted edge aperture view, 45x (LD = .35 millimeters). **Pararotalia? takayanagii** Matoba 10.199: edge view, 45x (LD = .20 millimeters). 10.200: ventral view, 45x (LD = .20 millimeters).



10.181. Edge view showing aperture, 13.5x (LD = 1.85 millimeters) (continued from Figure 9.180).

Hyalinea inflata Ujiie and Kusukawa (1969, p. 767, pl. 2, figures 1-3). 10.182. Side view, 45x (LD = .38 millimeters). 10.183. Ventral view, 45x (LD = .38 millimeters). Photographs of holotype (specimen no longer exists) from the National Science Museum (Tokyo, Shinjuku branch). The holotype was crushed during photography and the photographs of this species did not turn out well. They are included here because they are the only light photographic record of this species. This appears to be a distinct species; in the absence of a holotypic specimen, a lectotype should be designated to replace the holotype from the collections of the National Science Museum.

Miliammina echigoensis Asano and Inomata (**in** Asano 1952, p. 5, figures 21-24). 10.184. Side view of 4 chambered side, 45x (LD = .51 millimeters). 10.185. Side view showing aperture, 45x (LD = .44 millimeters). Photographs of Holotype (#75251) in the Tohoku University collections. This looks distinct from **M. fusca** (Brady 1870) with no apparent inner lining.

Nonion aimonoi Matsunaga (1963, p. 109, pl. 37, figures 2a and 2b). 10.186. Side view, 45x (LD = .49 millimeters). Photograph of holotype (#85387) in the Tohoku University collections. There is no question that this is a junior synonym of **Nonion affinis** (Reuss 1851) and not a distinct species.

Nonion nagasawaense Matsunaga (1963, p. 109, pl. 37, figures 7a and 7b). 10.187. Side view 13.5x (LD = 1.18 millimeters). 10.188. Edge view, 13.5x (LD = 1.18 millimeters). Photographs of holotype (#85201) in the Tohoku University collections. This looks like a distinct species.

Nonion nakosoense Asano (1949, p. 428, figure 2, nos. 14-17). 10.189. Edge view showing aperture, 13.5x (LD = .67 millimeters). 10.190. Side view, 13.5x (LD = .96 millimeters). Photographs of holotype (#67044) in the Tohoku University collections. This looks like a distinct species, although it is similar to **Nonionellina labraodorica** (Dawson 1860) in the North Atlantic, except that the sutures of this species are slightly filled with a line of clear calcite.

Nonionella hanzawai Asano (1953b, p. 52, figure 4a-4c). 10.191. Slanted dorsal view, 13.5x (LD = .74 millimeters). 10.192. Ventral view, 13.5x (LD = .67millimeters). Photographs of holotype (#75286) in the Tohoku University collections. This very odd species is definitely a distinct species.

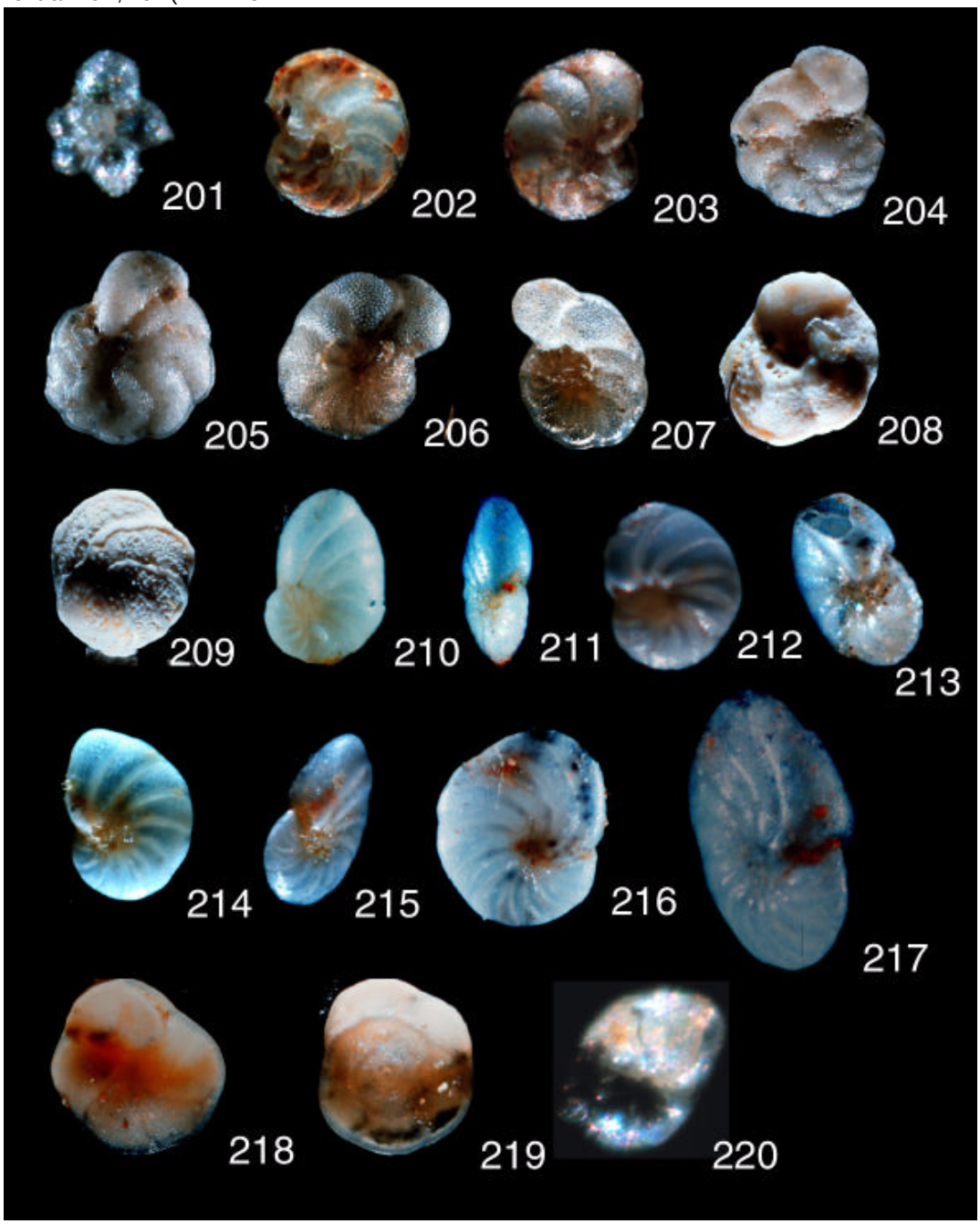
Nonionella higashiyamaensis Matsunaga (1963, p. 110, pl. 38, figure 3a-3c). 10.193. Side view, 45x (LD = .47 millimeters). 10.194. Edge view showing aperture, 45x (LD = .47 millimeters). Photographs of holotype (#85206) in the Tohoku University collections. This specimen is highly recrystallized, but very similar to **Nonionella turgida** (Williamson 1858) and hence a possible junior synonym of that species.

Paracassidulina nabetaensis Nomura (1983a, p. 98, pl. 2, figure 16a and b; pl. 5, figure 5; pl. 25, figure 7). 10.195. Side view showing aperture, 45x (LD = .58 millimeters). 10.196. Edge view showing aperture, 45x (LD = .58 millimeters). Photographs of paratype (#97406) in the Tohoku University collections. This species is similar in some ways to **Cassidulina reniforme** (Nörvang 1945), but its shape is much more elongate and chambers are elongated, so it appears to be a distinct species.

Paracassidulina quasicarinata Nomura (1983a, p. 100, pl. 2, figure 19a-c; pl. 25, figures 9-11). 10.197. Side view showing aperture, 45x (LD = .35 millimeters). 10.198. Slanted edge view showing aperture, 45x (LD = .35 millimeters). Photographs of paratype (#97254) in the Tohoku University collections. Scott suggests this is similar to **Islandiella teretis** (Tappan 1951), and hence is a junior synonym; Takayanagi indicates it is close to **I. Teretis,** but differs in umbilical and apertural features.

Pararotalia? takayanagii Matoba (1970, p. 63, pl. 6, figures 9 and 10). 10.199. Edge view, 45x (LD = .20 millimeters). 10.200. Ventral view, 45x (LD = .20 millimeters). Photographs of paratype (#91312C) in the Tohoku University collections. This very unusual species is certainly distinct. This species was subsequently placed in the genus **Murrayinella** by Takayanagi and Hasegawa (1987). (See also 11.201.)

Figure 11.201-220. Pararotalia? takayanagii Matoba 11.201: dorsal view, 45x (LD = .20 millimeters). **Planulina convexa** Takayanagi 11.202: ventral view, 45x (LD = .51 millimeters). 11.203:dorsal view, 45x (LD = .53 millimeters). **Planulina nipponica** Asano 11.204: ventral view, 13.5x (LD = 1.18 millimeters). 11.205: dorsal view, 13.5x (LD = 1.26 millimeters). **Planulina subdepressa** Asano 11.206: dorsal view, 13.5x (LD = 1.63 millimeters). 11.207: ventral view, 13.5x (LD = 1.63 millimeters). **Poroeponides cribroconcameratus** Asano and Uchio **in** Asano 11.208: ventral view, 7.5x (LD = 2.80 millimeters). 11.209: dorsal view, 7.5x (LD = 2.80 millimeters). **Pseudononion japonicum** Asano 11.210: side view, 13.5x (LD = .81 millimeters). 11.211: edge apertural view, 13.5x (LD = .81 millimeters). **Pseudononion kanbaraense** Matsunaga 11.212: side view, 45x (LD = .44 millimeters). 11.213: edge view, 45x (LD = .42 millimeters). **Pseudononion oinomikadoi** Matsunaga 11.214: side view, 45x (LD = .49 millimeters). 11.215: edge apertural view, 45x (LD = .49 millimeters). **Pseudononion trececum** Asano 11.216: side view, 13.5x (LD = 1.11 millimeters). 11.217: slanted edge view, 13.5x (LD = 1.11 millimeters). **Pseudoparella japonica** Asano 11.218: ventral view, 13.5x (LD = .89 millimeters). 11.219: dorsal view, 13.5x (LD = .13 millimeters). **Pseudoparella tamana** Kuwano 11.220: ventral view, 45x (LD = .13.



11.201. Dorsal view, 45x (LD = .20 millimeters) (continued from 11.200).

Planulina convexa Takayanagi (1953, p. 34, pl. 4, figure 14a-14c). 11.202. Ventral view, 45x (LD = .51 millimeters). 11.203. Dorsal view, 45x (LD = .53 millimeters). Photographs of holotype (#67145) in the Tohoku University collections. This species appears to be distinct.

Planulina nipponica Asano (1953a, p. 13, pl. 3, figure 13a-13c). 11.204. Ventral view, 13.5x (LD = .118 millimeters). 11.205. Dorsal view, 13.5x (LD = 1.26 millimeters). Photographs of holotype (#75269) in the Tohoku University collections. This looks like a distinct species because of the presence of a strong keel around its outer margin.

Planulina subdepressa Asano (1951a, p. 15, figures 16-18). 11.206. Dorsal view, 13.5x (LD = 1.63 millimeters). 11.207. Ventral view, 13.5x (LD = 1.63 millimeters). Photographs of holotype (no number on slide) in the Tohoku University collections. Scott considers this species to be a junior synonym of **Planulina wuellerstorfi** (Schwager 1866); Takayanagi finds that it is different because it has moderately curved and depressed sutures on the umbilical side.

Poroeponides cribroconcameratus Asano and Uchio (**in** Asano 1951c, p. 18, figures 132 and 133). 11.208. Ventral view, 7.5x (LD = 2.80 millimeters). 11.209. Dorsal view, 7.5x (LD = 2.80 millimeters). Photographs of holotype (#74703) in Tohoku University collections. This appears to be a distinct species.

Pseudononion japonicum Asano (1936b, p. 347, text figures a-c). 11.210. Side view, 13.5x (LD = .81 millimeters). 11.211. Edge view showing aperture, 13.5x (LD = .81 millimeters). Photographs of holotype (#21362) in the Tohoku University collections. This specimen appears to be the same as **Nonionella atlantica** Cushman (1947). **Pseudononion japonicum** is therefore the valid name for this well known Atlantic species.

Pseudononion kanbaraense Matsunaga (1963, p. 110, pl. 38, figure 8a-8c). 11.212. Side view, 45x (LD = .44 millimeters).

11.213. Edge view, 45x (LD = .42 millimeters). Photographs of holotype (#85211) in the Tohoku University collections. This species is very close to **P. japonicum**.

Pseudononion oinomikadoi Matsunaga (1963, p. 110, pl. 39, figure 1a-1c). 11.214. Side view, 45x (LD = .49 millimeters). 11.215. Edge view showing aperture, 45x (LD = .49 millimeters). Photographs of holotype (#85212) in the Tohoku University collections. This species is very similar to the previous two **Pseudononion** species (Figures 210-213).

Pseudononion trececum Asano (1936c, p. 622, pl. 33, figure 7a-7c). 11.216. Side view, 13.5x (LD = 1.11 millimeters). 11.217. Slanted edge view, 13.5x (LD = 1.11 millimeters). Photographs of lectotype (#21375) in the Tohoku University collections. This may be a distinct species or it could be a variation of the other three **Pseudononion** species.

Pseudoparella japonica Asano (1949, p. 430, figure 2, nos. 2-4). 11.218. Ventral view, 13.5x (LD = .89 millimeters). 11.219. Dorsal view, 13.5x (LD = .89 millimeters). Photographs of holotype (#67045) in the Tohoku University collections. This appears to be a distinct species. The genus for this species was changed to **Alabamina** (Takayanagi and Hasegawa 1987).

Pseudoparella tamana Kuwano (1950, p. 317, figure 5a-5c). 11.220. Ventral view, 45x (LD = .13 millimeters). Photographs of ideotype (no number) in the National Science Museum (Tokyo, Shinjuku branch). The photographs here are not high quality because the specimen was disintegrating as it was being photographed. In spite of the poor quality of the photographs, the form of the species appears to have a thinner test wall than **E. takayanagii** Iwasa and slightly less distinct sutures. This is also similar to **Stetsonia arctica** (Green 1960), which has a thin test wall and less distinct sutures. Unfortunately, this is a problem that will not be solved easily in the absence of the author of the species. This may be another species that should have its type figures designated as lectotypes. (See also 12.221.)

Figure 12.221-240. Pseudoparella tamana Kuwano 12.221: dorsal view, 45x (LD = .11 millimeters). **Pseudorotalia borneensis** Ujiie 12.222: dorsal view, 13.5x (LD = .89 millimeters). 12.223: ventral view, 13.5x (LD = .89 millimeters). **Rotalia ? minuta** Takayanagi 12.224: ventral view, 45x (LD = .24 millimeters). 12.225: dorsal view, 45x (LD = .26 millimeters). **Rotalia sadoensis** Asano 12.226: ventral view, 10x (LD = 1.40 millimeters). 12.227: dorsal view, 10x (LD = 1.40 millimeters). **Siphotextularia masudai** Asano 12.228: side view, 13.5x (LD = .96 millimeters). 12.229: edge apertural view, 13.5x (LD = .96 millimeters). **Spiroplectammina higuchii** Takayanagi 12.230: side view, 45x (LD = .42 millimeters). 12.231: apertural view, 45x (LD = .42 millimeters). **Spiroplectammina niigataensis** Asano and Inomata **in** Asano. 12.232: side view, 13.5x (LD = 1.56 millimeters). 12.233: edge apertural view, 13.5x (LD = 1.56 millimeters). **Spiroplectammina shibataensis** Matsunaga 12.234: side view, 22.5x (LD = .93 millimeters). **Textularia andenensis** Asano 12.235: side view, 13.5x (LD = 2.07 millimeters). 12.236: edge apertural view, 13.5x (LD = 2.07 millimeters). **Textularia aokii** Asano 12.237: side view, 13.5x (LD = .96 millimeters). 12.238: edge apertural view, 13.5x (LD = .96 millimeters). **Textularia hoppoensis** Nakamura 12.239: side view, 13.5x (LD = 2.29 millimeters). **Textularia intosiana** Nakamura 12.240: side view, 7.5x (LD = 3.06 millimeters).

12.221. Dorsal view, 45x (LD = .11 millimeters) (continued from 11.220).

Pseudorotalia borneensis Ujiie (1977, p. 95, pl. 18, figures 1-3, pl. 21, figures 7 and 8). 12.222. Dorsal view, 13.5x (LD = .89 millimeters). 12.223. Ventral view, 13.5x (LD = .89 millimeters). Photographs of holotype (#1008) in the National Science Museum (Tokyo, Shinjuku branch). This is a very distinctive species with incised ventral sutures and a well developed keel on the periphery.

Rotalia? minuta Takayanagi (1955, p. 52, figure 29a-29c). 12.224. Ventral view, 45x (LD = .24 millimeters). 12.225. Dorsal view, 45x (LD = .26 millimeters). Photographs of the holotype (#67152) in the Tohoku University collections. This species is remarkably similar to **Pararotalia takayanagii** Matoba, especially in the texture of the test. If these are the same, then Matoba's species is a junior synonym. Hasegawa notes that **minuta** is different in the periphery of the test and other features, but Scott still believes this one is a variation of Takayanagi's species. The genus for this species was changed to **Murrayinella** (Takayanagi and Hasegawa 1987).

Rotalia sadoensis Asano (1951c, p. 16, figures 120 and 121). 12.226. Ventral view, 10x (LD = 1.40 millimeters). 12.227. Dorsal view, 10x (LD = 1.40 millimeters). Photographs of holotype (#67198) in the Tohoku University collections. This is an interesting species because of the slits on the dorsal sutures and truncated ventral sutures. However, it could also be an extreme variation of **Ammonia beccarii** (Linne 1758).

Siphotextularia masudai Asano (1953a, p. 17, pl. 1, figure 8a and 8b). 12.228. Side view, 13.5x (LD = .96 millimeters). 12.229. Edge view showing aperture, 13.5x (LD = .96 millimeters). Photographs of holotype (#75267) in the Tohoku University collections. This species is identical to **S. rolhauseri** (Phleger and Parker 1951) and is a junior synonym of that species.

Spiroplectammina higuchii Takayanagi (1953, p. 27, pl. 4, figures 1a and 1b). 12.230. Side view, 45x (LD = .42 millimeters). 12.231. Apertural view, 45x (LD = .42 millimeters). Photographs of holotype (#67134) in the Tohoku University collections. This species is certainly different from any other Neogene species of this genus.

Spiroplectammina niigataensis Asano and Inomata (**in** Asano 1952, p. 4, figures 15-17). 12.232. Side view, 13.5x (LD = 1.56 millimeters). 12.233. Edge view showing aperture, 13.5x (LD = 1.56 millimeters). Photographs of holotype (#75252) in the Tohoku University collections. This is also a different species from any other Neogene form.

Spiroplectammina shibataensis Matsunaga (1963, p. 106, pl. 25, figure 2). 12.234. Side view, 22.5x (LD = .93 millimeters). Photograph of holotype (#85040) in the Tohoku University collections. This is a very interesting species, quite distinct from the other Japanese species of this genus as well as those from anywhere else, with a large coil and tapering biserial chambers.

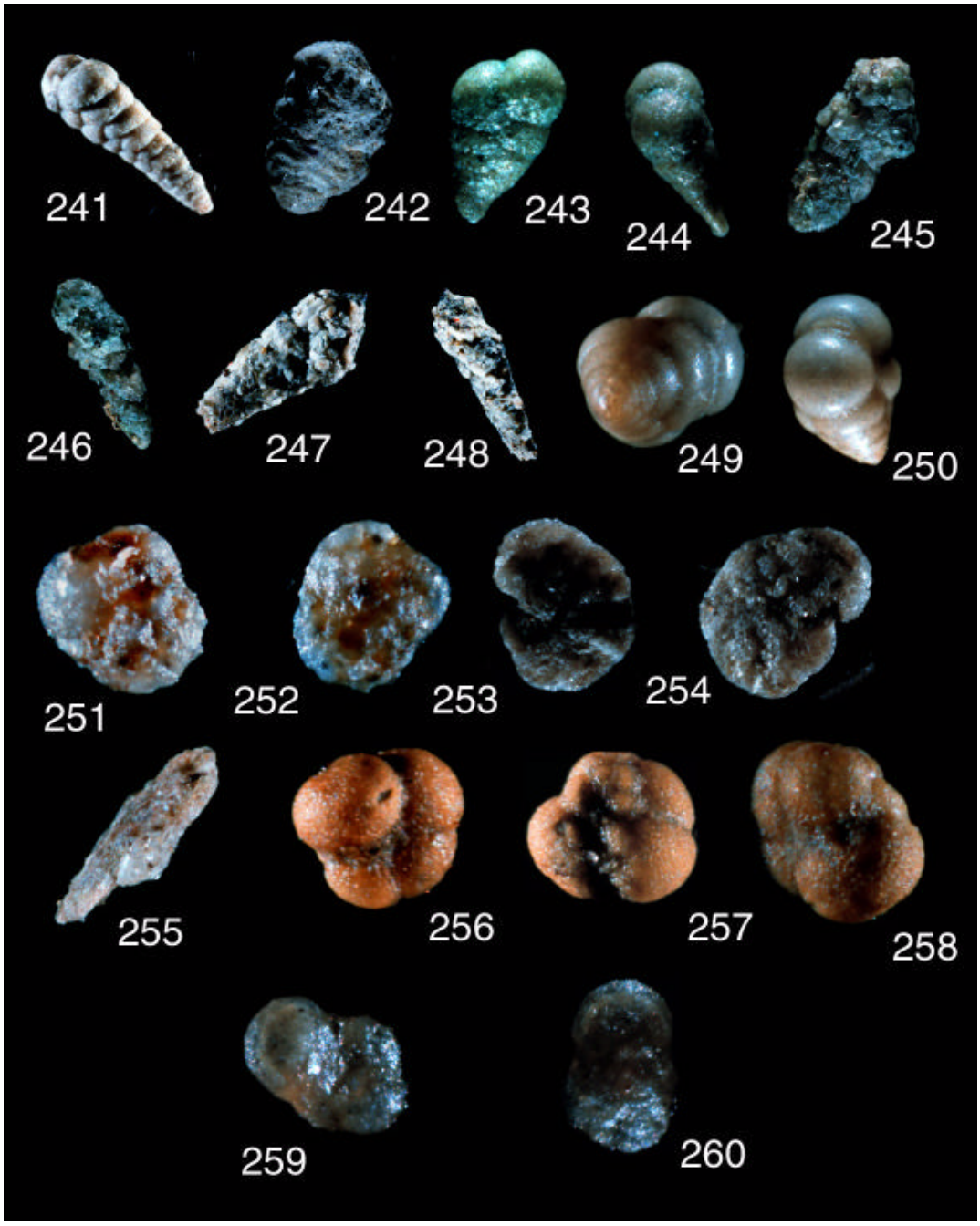
Textularia andenensis Asano (1950c, p. 2, figures 5 and 6). 12.235. Side view, 13.5x (LD = 2.07 millimeters). 12.236. Edge view showing aperture, 13.5x (LD = 2.07 millimeters). Photographs of a specimen that is not the holotype, but was the only specimen of this species (#66190) in the Tohoku University collections. Scott places this species with **T. conica** (d'Orbigny 1839), making this species a junior synonym.

Textularia aokii Asano (1936d, p. 325, pl. 36, figure 1a and 1b). 12.237. Side view, 13.5x (LD = .96 millimeters). 12.238. Edge view showing aperture, 13.5x (LD = .96 millimeters). Photographs of holotype (#21330) in the Tohoku University collections. This species resembles a number of different species from the Mediterranean, but may be a distinct species.

Textularia hoppoensis Nakamura (1937, p. 134, pl. 10, figure 4a and 4b). 12.239. Side view, 13.5x (LD = 2.29 millimeters). Photograph of holotype (#60855) in the Tohoku University collections. The very coarse grains making up the specimen obscure the sutures, but it is probably a distinct species.

Textularia intosiana Nakamura (1937, p. 134, pl. 10, figures 5 and 6). 12.240. Side view, 7.5x (LD = 3.06 millimeters). Photographs of paratype (#60857) because the holotype in the Tohoku University collections was broken. This is a very distinctive species; the sutures and aperture are very easy to see, unlike most species of this genus. (See also 13.241.)

Figure 13.241-260. **Textularia intosiana** Nakamura 13.241: edge aperture view, 7.5x (LD = 3.06 millimeters). **Textularia notoensis** Asano 13.242: side apertural view, 10x (LD = 2.60 millimeters). **Textularia sintikuensis** Nakamura 13.243: side view, 45x (LD = .67 millimeters). 13.244: edge apertural view, 45x (LD = .67 millimeters). **Textularia taiwanica** Nakamura 13.245: slanted side view, 13.5x (LD = 2.00 millimeters). 13.246: edge aperture view, 13.5x (LD = 2.00 millimeters). **Textularia uedai** Asano 13.247: side view, 13.5x (LD = 2.07 millimeters). 13.248: edge apertural view, 13.5x (LD = 2.07 millimeters). **Tosaia hanzawai** Takayanagi 13.249: "dorsal" view, 45x (LD = .47 millimeters). 13.250: Apertural view, 45x (LD = .58 millimeters). **Trochammina bullata** Takayanagi 13.251: ventral view, 13.5x (LD = .96 millimeters). 13.252: dorsal view, 13.5x (LD = .96 millimeters). **Trochammina nipponica** Asano 13.253: ventral side, 13.5x (LD = 1.48 millimeters). 13.254: dorsal side, 13.5x (LD = 1.48 millimeters). 13.255: edge view, 13.5x (LD = 1.26 millimeters). **Trochammina nobensis** Asano 13.256: ventral view, 45x (LD = .49 millimeters). 13.257: dorsal view, 45x (LD = .49 millimeters). 13.258: edge view, 45x (LD = .49 millimeters). **Trochammina yubarensis** Takayanagi 13.259: ventral view, 45x (LD = .44 millimeters). **Trochammina yubarensis** Takayanagi 14.260: dorsal view, 45x (LD = .44 millimeters).



13.241. Edge view showing aperture, 7.5x (LD = 3.06 millimeters) (continued from 12.240).

Textularia notoensis Asano (1953a, p. 20, pl. 1, figures 4 and 5). 13.242. Side view showing aperture, 10x (LD = 2.60 millimeters). Photograph of holotype (#75268) in the Tohoku University collections. This is a very coarse-grained species that looks like a distinct species.

T**extularia sintikuensis** Nakamura (1937, p. 135, pl. 10, figure 7a and 7b). 13.243. Side view, 45x (LD = .67 millimeters). 13.244. Edge view showing aperture, 45x (LD = .67 millimeters). Photographs of holotype (#60858) in the Tohoku University collections. This is a distinct species.

Textularia taiwanica Nakamura (1937, p. 135, pl. 10, figure 8a and 8b). 13.245. Slanted side view, 13.5x (LD = 2.00 millimeters). 13.246. Edge view showing aperture, 13.5x (LD = 2.00 millimeters). Photographs of holotype (#60859) in the Tohoku University collections. This species was placed in synonymy with **T. foliacea** Heron-Allen and Earland by Huang (1968).

Textularia uedai Asano (1936e, p. 611, pl. 30, figure 1a and 1b). 13.247. Side view, 13.5x (LD = 2.07 millimeters). 13.248. Edge view showing aperture, 13.5x (LD = 2.07 millimeters). Photographs of holotype (#21363) in the Tohoku University collections. This species was placed in synonymy with T**. foliacea** by Asano (1950c).

Tosaia hanzawai Takayanagi (1953, p. 30, pl. 4, figure 7a and 7b). 13.249. "Dorsal" view, 45x (LD = .47 millimeters). 13.250. Apertural view, 45x (LD = .58 millimeters). Photographs of holotype (#67147) in the Tohoku University collections. This is a prominent species in many deep-sea environments; it is often confused with **Eggerella bradyi** (Cushman 1911). However, this is a calcareous species, not agglutinated, and so it is distinct. 13.249 is the first picture in which the first five chambers are visible if the photo is enlarged; Takayanagi, the author of this species, had never been able to see the first few chambers of this species until we projected this slide on a screen where it was still in focus even at room size. The value of the SLM was apparent with this species.

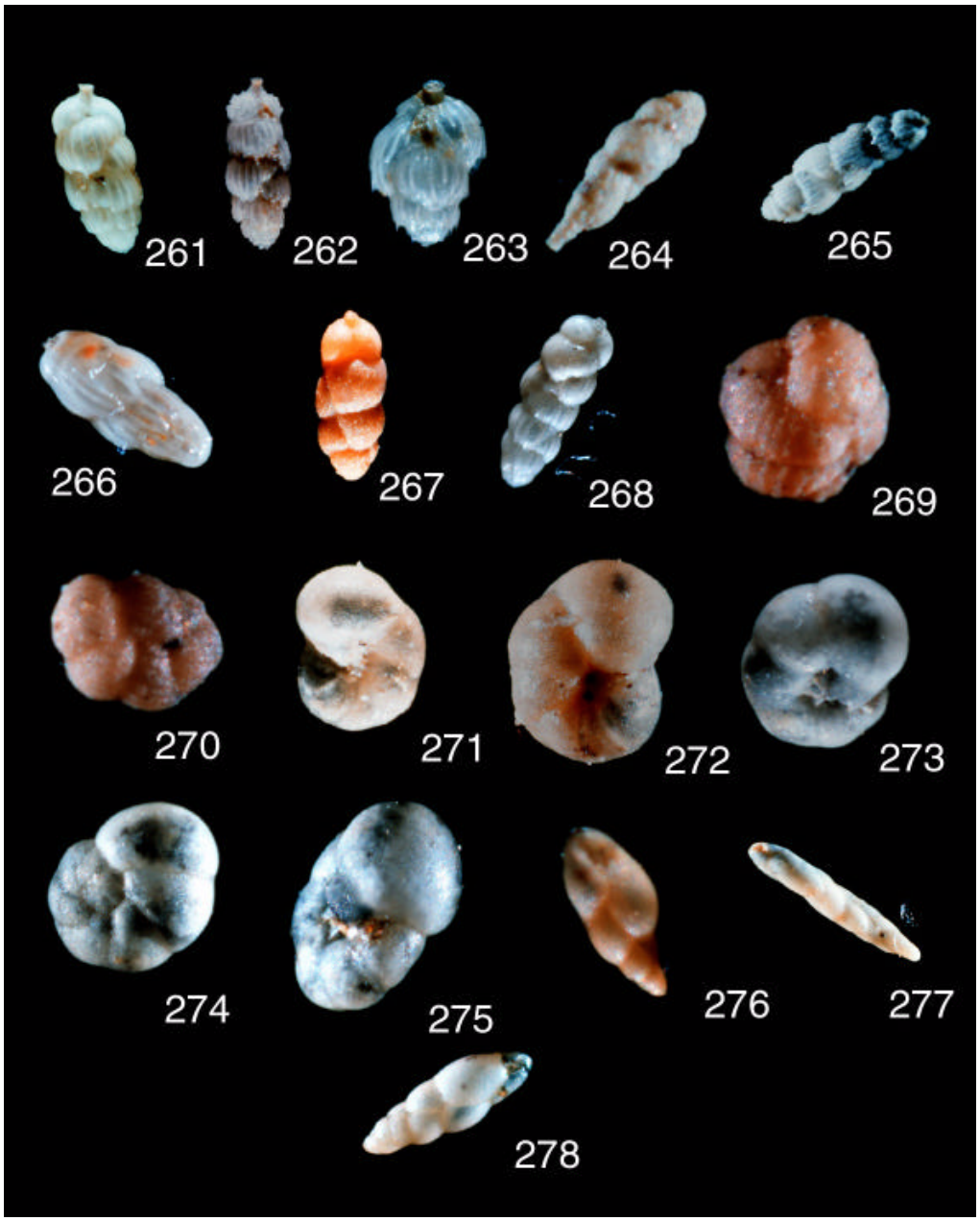
Trochammina bullata Takayanagi (1960, p. 85, pl. 4, figure 1a-1c). 13.251. Ventral view, 13.5x (LD = .96 millimeters). 13.252. Dorsal view, 13.5x (LD = .96 millimeters). Photographs of holotype (#74862) in the Tohoku University collections. Specimens observed in the Holocene of the North Atlantic (Cole 1981; Scott 1987) were referred to this species on the basis of type illustrations. Examination of type specimens established that they were not the same as those observed in North Atlantic sediments, demonstrating the importance of looking at original types.

Trochammina nipponica Asano (1953b, p. 54, figure 5a-5c). 13.253. Ventral side, 13.5x (LD = 1.48 millimeters). 13.254. Dorsal side, 13.5x (LD = 1.48 millimeters). 13.255. Edge view, 13.5x (LD = 1.26 millimeters). Photographs of holotype (#75288) in the Tohoku University collections. The closest species to this one is **T. macrescens** Brady (1870). But unlike any other trochamminids, this one has almost a "**Cibicides"** like appearance because of deformation caused by lateral compression in the rock.

Trochammina nobensis Asano (1951d, p. 8, figures 3 and 4). 13.256. Ventral view, 45x (LD = .49 millimeters). 13.257. Dorsal view, 45x (LD = .49 millimeters). 13.258. Edge view, 45x (LD = .49 millimeters). Photographs of holotype (#67101) in the Tohoku University collections. This species was subsequently determined to be a planktic foraminifera, **Neogloboquadrina nobensis**, by Takayanagi and Hasegawa (1987). It is illustrated here to avoid any confusion that might exist.

Trochammina yubarensis Takayanagi (1960, p. 87, pl. 4, figure 4a-4c). 13.259. Ventral view, 45x (LD = .44 millimeters). Photographs of holotype (#74865) in the Tohoku University collections. This is not a Neogene form, but because it was described in the same publication as **T. bullata**, it is included here. It is certainly not like any Neogene form. 13.260. Dorsal view, 45x (LD = .44 millimeters). Note: Jung (1988) has made a comprehensive study of all Japanese forms of the uvigerinids using a variety of characters to describe them, including toothplates, wall structure, and internal structures. He obviously looked at many more specimens than in this study so our opinions are based on some of his observations. However, Scott still feels that some of these forms are close to **U. Peregrina**, a form never mentioned by Jung.

Figure 14.261-278. Uvigerina akitaensis Asano 14.261: side view, 13.5x (LD = 1.33 millimeters). **Uvigerina asanoi** Matsunaga 14.262: side view, 13.5x (LD = 1.33 millimeters). **Uvigerina peregrina** Cushman **shiwoensis** Asano 14.263: side view, 13.5x (LD = .96 millimeters). **Uvigerina pseudoampullacea** Asano 14.264: slanted side view, 13.5x (LD = .89 millimeters). **Uvigerina schencki** Asano 14.265: slanted side view, 13.5x (LD = 1.04 millimeters). **Uvigerina substriata** Asano 14.266: side view, 13.5x (LD = 1.48 millimeters). **Uvigerina urnula** d'Orbigny **shiiyaensis** Matsunaga 14.267: side view, 13.5x (LD = 1.11 millimeters). **Uvigerina yabei** Asano 14.268: slanted edge view, 13.5x (LD = 1.78 millimeters). **Uvigerinella quadrata** Iwasa 14.269: apertural view, 45x (LD = .42 millimeters). 14.270: side view, 45x (LD = .47 millimeters). **Valvulinera masudai** Asano 14.271: ventral view, 13.5x (LD = 1.11 millimeters). 14.272: dorsal view, 13.5x (LD = 1.11 millimeters). **Valvulinera sadonica** Asano 14.273: slanted ventral side, 13.5x (LD = 1.18 millimeters). **Valvulinera sadonica** Asano 14.274: dorsal view, 13.5x (LD = 1.26 millimeters). 14.275: edge apertural view, 13.5x (LD = 1.26 millimeters). **Virgulina akitaensis** Iwasa 14.276: apertural side view, 45x (LD = .42 millimeters). **Virgulina complanata** Egger **fugeshiensis** Asano 14.277: side apertural view, 13.5x (LD = 1.85 millimeters). **Virgulina ishikiensis** Asano 14.278: side apertural view, 45x (LD = .67 millimeters).



Uvigerina akitaensis Asano (1950b, p. 14, figures 60-62). 14.261. Side view, 13.5x (LD = 1.33 millimeters). Photograph of holotype (no number) in the Tohoku University collections. Scott places this species into **U. peregrina** Cushman (1923). However, we did not examine internal structures as did Jung (1988), who placed this species in the genus **Euuvigerina** on the basis of toothplate characteristics.

Uvigerina asanoi Matsunaga (1963, p. 113, pl. 42, figure 10a and 10b). 14.262. Side view, 13.5x (LD = 1.33 millimeters). Photograph of holotype (#85260) in the Tohoku University collections. This species was placed in synonymy with **U. akitaensis** by Jung (1988).

Uvigerina peregrina Cushman **shiwoensis** Asano (1958, p. 35, pl. 6, figures 5-8). 14.263. Side view, 13.5x (LD = .96 millimeters). Photograph of holotype (#77174) in the Tohoku University collections. Jung (1988) elevated this to species status (**Euuvigerina shiwoensis),** suggesting that this species was much closer to **E. aculeata** (d'Orbigny 1846) than to **U. peregrina,S** but nevertheless a distinct species.

Uvigerina pseudoampullacea Asano (1938c, p. 613, pl. 17(6), figures 28 and 29). 14.264. Slanted side view, 13.5x (LD = .89 millimeters). Photograph of holotype (#21428) in the Tohoku University collections. Jung (1988) commented that this species is similar to many spinose forms, but is distinct. Scott agrees that it is similar to many described spinose forms, but cannot say if it is a junior synonym of any older species. Jung (1988) placed this species into **Neouvigerina**.

Uvigerina schencki Asano (1950b, p. 17, figures 74 and 75). 14.265. Side view, 13.5x (LD = 1.04 millimeters). Photograph of holotype (#66939) in the Tohoku University collections. Jung (1988) placed this species into the genus **Euuvigerina**.

Uvigerina substriata Asano (1938c, p. 614, pl. 17(6), figures 21 and 22). 14.266. side view, 13.5x. Photograph of holotype (#21430) in the Tohoku University collections. This species was not discussed by Jung (1988), but it appears to be distinct from the other Japanese uvigerinids.

Uvigerina urnula d'Orbigny **shiiyaensis** Matsunaga (1963, p. 114, pl. 43, figure 4a and 4b). 14.267. Side view, 13.5x (LD = 1.48 millimeters). Photograph of holotype (#85266) in the Tohoku University collections. This may be a distinct subspecies.

Uvigerina yabei Asano (1938c, p. 613, pl. 17(6), figures 1 and 2). 14.268. Edge view, 13.5x (LD = 1.11 millimeters). Photograph of holotype (#21429) in the Tohoku University collections. Jung (1988) separated this species from **U. akitaensis** on the basis of costae and larger size of this species but, earlier in the same paper, admitted that these may not be valid criteria**.** Jung pointed out that there has been much confusion in Japan over this species, and it is not hard to see why.

Uvigerinella quadrata Iwasa (1955, p. 17, text figure 3a-3c). 14.269. Apertural view, 45x (LD = .42 millimeters). 14.270. Side view, 45x (LD = .47 millimeters). Photographs of holotype (#65503) in the Tohoku University collections. This looks like a distinct species.

Valvulinera masudai Asano (1953a, p. 20, figure 16a-16c). 14.271. Ventral view, 13.5x (LD = 1.11 millimeters). 14.272. dorsal view, 13.5x (LD = 1.11 millimeters). Photographs of holotype (# 75270) in the Tohoku University collections. It is probably a distinct species, but it is a badly etched specimen, making it difficult to evaluate.

Valvulinera sadonica Asano (1951a, p. 8, figures 55-57). 14.273. Slanted ventral side, 13.5x (LD = 1.18 millimeters). 14.274. Dorsal view, 13.5x (LD = 1.26 millimeters). 14.275. Edge apertural view, 13.5x (LD = 1.26 millimeters). Photographs of paratype (#67179) in the Tohoku University collections. This is a very interesting species that has some rare features for this genus, such as the slightly covered umbilical area and what appears to be almost a tubular extension into the umbilical area.

Virgulina akitaensis Iwasa (1955, p. 17, text figure 2a and 2b). 14.276. Apertural side view, 45x (LD = 1.48 millimeters). Photograph of holotype (#65502) in the Tohoku University collections. This species is very close to **Fursenkoina fusiformis** (Williamson 1858).

Virgulina complanata Egger **fugeshiensis** Asano (1953a, p. 20, pl. 2, figure 22). 14.277. Side view showing aperture, 13.5x (LD = 1.85 millimeters). Photograph of holotype (#75269) in the Tohoku University collections. The slide containing this specimen was labeled as **V. notoensis,** but the species name was changed to **fugeshiensis** in the publication. This species is listed by Takayanagi and Hasegawa (1987), as belonging to the genus **Fursenkoina**; however, it does not appear to be a variation of **F. complanata,** but rather a distinct species.

Virgulina ishikiensis Asano (1949, p. 428, fig.1, nos. 45, 46, 48, and 56). 14.278. Side view showing aperture, 45x (LD = .67 millimeters). Photograph of holotype (#67041) in the Tohoku University collections. This is another variation of **F. fusiformis.**

APPENDIX

Availability of slides or CD-ROMs

Color slides of the figures listed above are available at cost ($2CAN each) from: Japanese Foraminifera Collection, Audio-Visual Department, Studley Campus, Dalhousie University, Halifax, Nova Scotia B3H3J5 Canada, or from the Institute of Geology and Paleontology, Tohoku University, Sendai 980, Japan. Individual slides can be obtained by referring to the figure numbers or the complete set (278 slides), which would cost $556CAN. The CD-ROM with all the species as well as the plates contained here is available at cost ($20CAN) from the Centre for Marine Geology, Dalhousie University. We provide this as a service to the community, which may save expensive trips to Japan or at least help workers to focus on some individual species.

ACKNOWLEDGMENTS

Many people made this project possible in Japan and Canada. We thank all the staff and students at the Institute of Geology and Paleontology, Tohoku University, who assisted the authors in many ways from developing film to setting up equipment. We give special thanks to Dr. Y. Tanimura (National Science Museum, Tokyo, Shinjuku branch), who helped Scott locate type material in the museum. Scott went through these and subsequently placed all of Kuwano's types into the main museum collection. Unfortunately, many of the types were ruined because they had no cover slips, but at least some were saved. Chloe Younger and Tom Duffett of the Centre for Marine Geology scanned all the slides and worked on the images for the plates and the CD-ROM. The work was funded by a Bilateral Exchange Programme of the Japanese Society for the Promotion of Science (JSPS) and the Natural Sciences and Engineering Research Council (NSERC, Canada). Some of the finishing work was funded by an NSERC research grant to Scott.

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