# Benthonic Smaller Foraminifera from the Oil Fields of Northern Japan

# Benthonic Smaller Foraminifera from the Oil Fields of Northern Japan

Takashi Matsunaga

(With 21 tables, 4 text-figs., and plates 24-52)


## ABSTRACT

Surface and subsurface geology undertaken parallel with micropaleontological studies of the Foraminifera has resulted in the discrimination of foraminiferal zonules. These zonules extend over wide areas and show remarkable uniformity in their specific compositions and stratigraphic levels within the respective geological columns of the different areas distributed from Akita Prefecture in the north, to Niigata Prefecture in the south via Yamagata Prefecture. Zoning by Foraminifera during Tsugawa to Nishiyama time in the Niigata oil-fields and from Nishikurosawa to Tentokuji time in the Akita and Yamagata oil-fields was rendered possible by the guide species. Among the deposits younger than the Tentokuji-Nishiyama time, zoning was based upon differences in the fauna and changes in their assemblages and frequency.

Faunal changes in both time and space have proved to be suitable for analyses of the conditions under which the Foraminifera once lived. The Foraminifera are good indicators of change in environmental conditions and for sectioning of the different stratigraphic units along the coast of the Japan Sea.

The Foraminifera studied in this article amounts to 114 genera and 360 species, among which one genus and 35 species or subspecies are described as new to science. Details are given as to their precise levels in the Neogene Tertiary formations dealt with in this work. Indications are given as to rock facies of the formations, place of depository of the specimens and localities of their occurrences.


## INTRODUCTION

In Northeastern Honshu, Japan, more than 3,000 meters thick Neogene Tertiary deposits are superposed with unconformity upon the pre-Neogene rocks. These deposits are distributed from Aomori Prefecture in the north to Toyama and Nagano Prefectures in the south along the coast of the Japan Sea. Oil is produced mainly from the Miocene formations in Akita, Yamagata and Niigata Prefectures.

The present work lists and illustrates the smaller Foraminifera (benthonic) from the Neogene Tertiary formations of the oil-fields, and records their stratigraphic occurrences. An attempt is made on their intercorrelation within the oil-fields of Japan.

Thanks are due to the Japan Petroleum Exploration Company and the Teikoku Oil Company for the permission to publish this work. Deep appreciation is expressed to Professors Kiyoshi Asano, Kotora Hatai and Enzo Kon'no of the Tohoku University for their kind guidance. Acknowledgements are due to Drs. Yoshio Ishida, Hidezo Aimono and Messrs. Tsuuri Nakazawa, Uichi Echizenya, Hisaya Shinbo, Kikuo Watanabe, Hiroshi Kamada of the Japan Petroleum Exploration Company and to Dr. Tsuneteru Oinomikado of the Arabian Oil Company for their encouragement.

## HISTORICAL REVIEW

Micropaleontological investigations of the fossil Foraminifera by the Japanese oil companies were commenced systematically in 1940, chiefly by Tsuneteru Oinomikado, then of

the Teikoku Oil Company. Subsequently the writer and his collaborators continued detailed biostratigraphic works on the oil-fields of Japan, especially of Akita, Yamagata and Niigata Prefectures under the guidance of Dr. Kiyoshi Asano of the Tohoku University.

At present more than ten paleontologists of the Japan Petroleum Exploration Company and the Teikoku Oil Company are engaged in micropaleontologic analysis of the Cretaceous and Tertiary Foraminifera for petroleum exploration and exploitation of Japan.

## BIOSTRATIGRAPHICAL NOTES

In Akita, Yamagata and Niigata Prefectures (Figs. 1–4), different biostratigraphic sequences have been employed because of the different bio-facies in the respective sedimentation basins.

By the guide species of benthonic and planktonic Foraminifera, the Neogene Tertiary rocks have been classified into five zones in ascending order as:

*Globorotalia* cf. *fohsi* Zone
*Spirosigmoilinella compressa* Zone
*Miliammina echigoensis* Zone
*Uvigerina subperegrina* Zone
*Cribroelphidium yabei* Zone

The correlations of these zones and zonules are shown in Tables 1–19, and the faunal changes in the zones in Table 21.

### a) *Globorotalia* cf. *fohsi* Zone

The formations characterized by "*Globorotalia* cf. *fohsi*" are included in this zone. The zone yielded a cosmopolitan fauna, which indicates the middle-lower Miocene. The important benthonic species of this zone are:

*Haplophragmoides renzi* Asano
*Hopkinsina imogawaensis* Matsunaga, n. sp.
*H. morimachiensis* Matsunaga, n. sp.
*H. nanataniensis* Matsunaga, n. sp.
*H. shinboi* Matsunaga, n. sp.
*Plectina nipponica* Asano
*Spiroplectammina niigataensis* Asano
*Spirosigmoilinella compressa* Matsunaga
*Rotalia tanosawaensis* Iwasa and Kikuchi
*R. tochigiensis* Uchio

### b) *Spirosigmoilinella compressa* Zone

The strata between the upper limit of the geological range of *Globorotalia* cf. *fohsi* and that of *Spirosigmoilinella compressa* are included in this zone. In this zone, there is a part composed of hard mudstone, which has yielded no Foraminifera in many cases. In this case, the strata between the upper limit of *Globorotalia* cf. *fohsi* and the lower range of *Miliammina echigoensis* is included in this zone.

The important species from this zone are:

*Cibicides malloryi* Matsunaga, n. sp.
*Gyroidina orbicularis* d'Orbigny
*Haplophragmoides renzi* Asano
*Hopkinsina imogawaensis* Matsunaga, n. sp.
*H. morimachinesis* Matsunaga, n. sp.
*H. nanataniensis* Matsunaga, n. sp.
*H. shinboi* Matsunaga, n. sp.
*Plectina nipponica* Asano
*Rotalia tanosawaensis* Iwasa and Kikuchi
*R. tochigiensis* Uchio
*Spiroplectammina niigataensis* Asano
*Spirosigmoilinella compressa* Matsunaga

### c) *Miliammina echigoensis* Zone

The base of this zone is defined by the upper limit of *Spirosigmoilinella compressa* or the lower limit of *Miliammina echigoensis*. The upper limit of the zone is marked by the highest appearance *Miliammina echigoensis*.

In the upper part of this zone Recent species are abundant and zone markers become

FIG. 1

OUTLINE MAP OF NORTHERN JAPAN

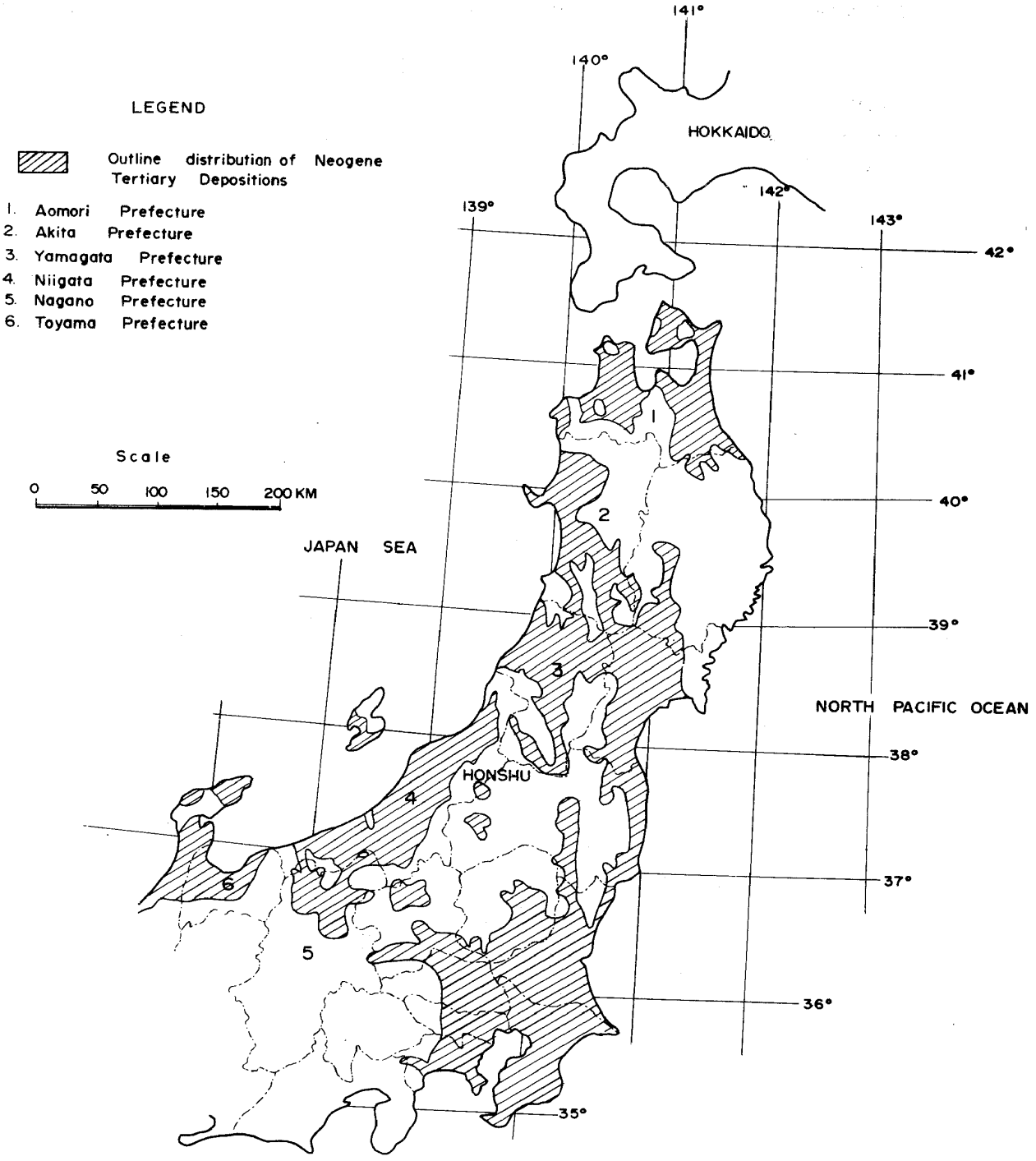


FIG. 2

INDEX MAP OF AKITA PREFECTURE SHOWING LOCATION OF INVESTIGATED SECTIONS.

1. North Akita district
2. South Noshiro district
3. Oga district
4. Wada district
5. Yuri district
6. Yajima district

LEGEND

Surface section

Well section

Town

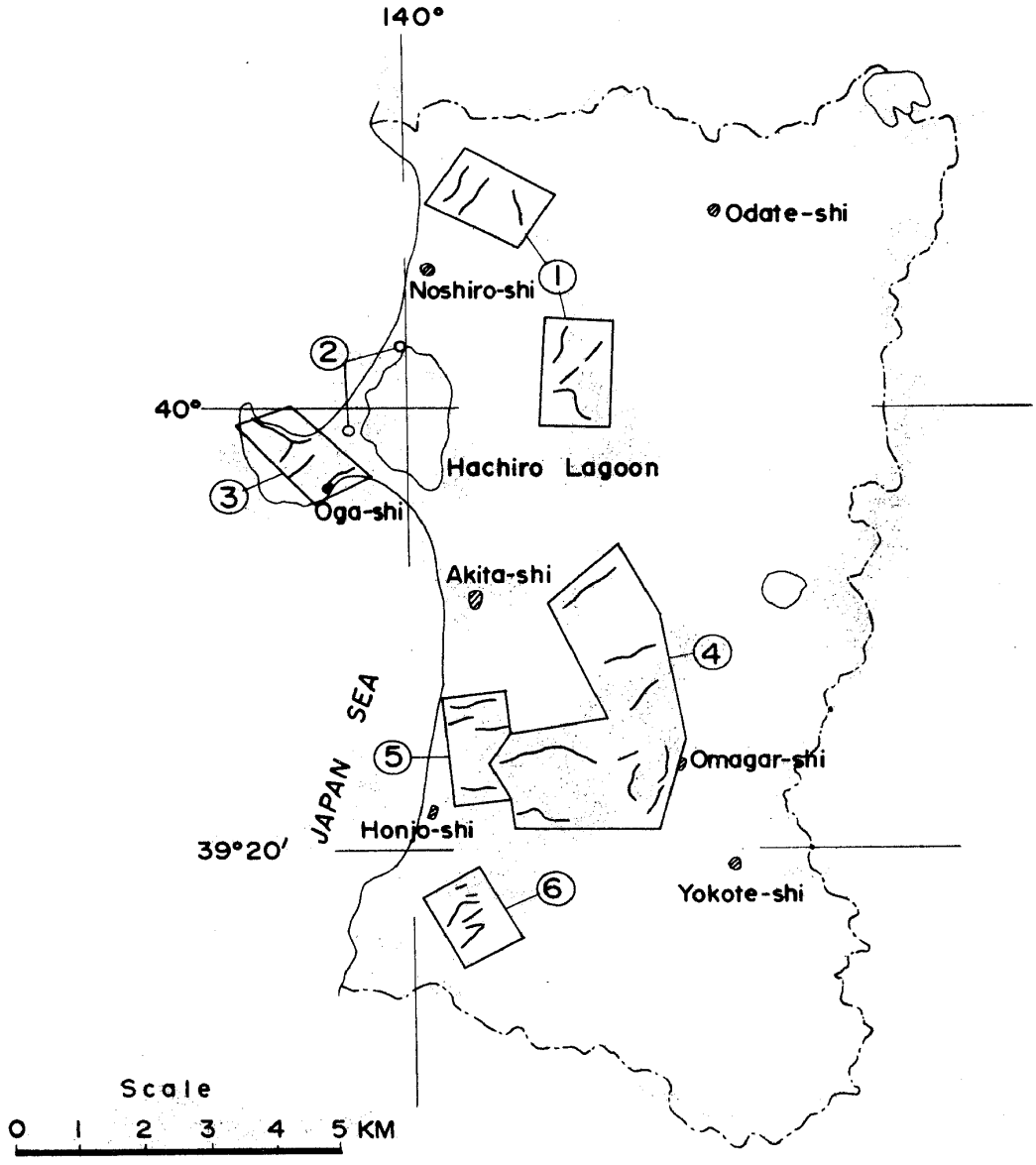


FIG. 3

INDEX MAP OF YAMAGATA PREFECTURE SHOWING LOCATION OF INVESTIGATED SECTIONS

1. East Sakata district
2. Karikawa district
3. North Shinjo district

REGEND

Surface section

Well section

Town

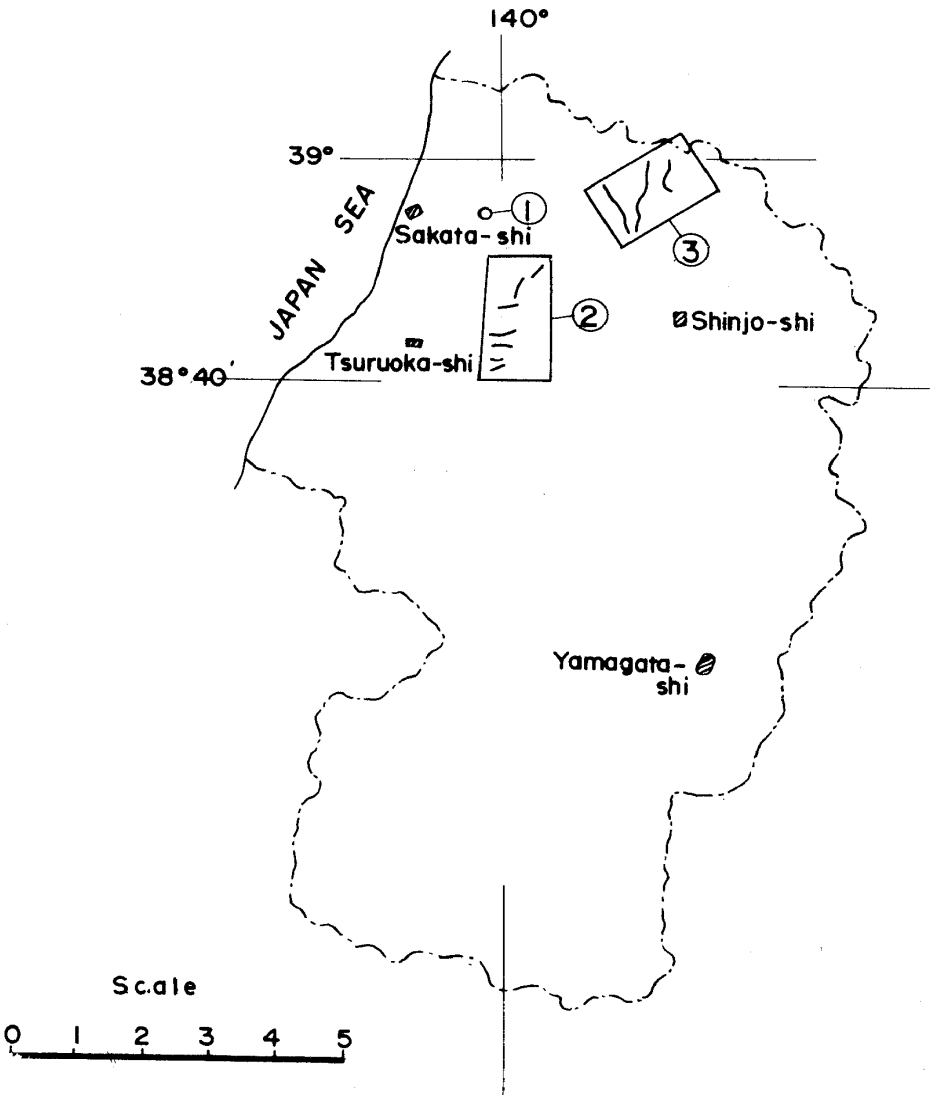


FIG. 4

INDEX MAP OF NIIGATA PREFECTURE SHOWING LOCATION OF INVESTIGATED SECTIONS

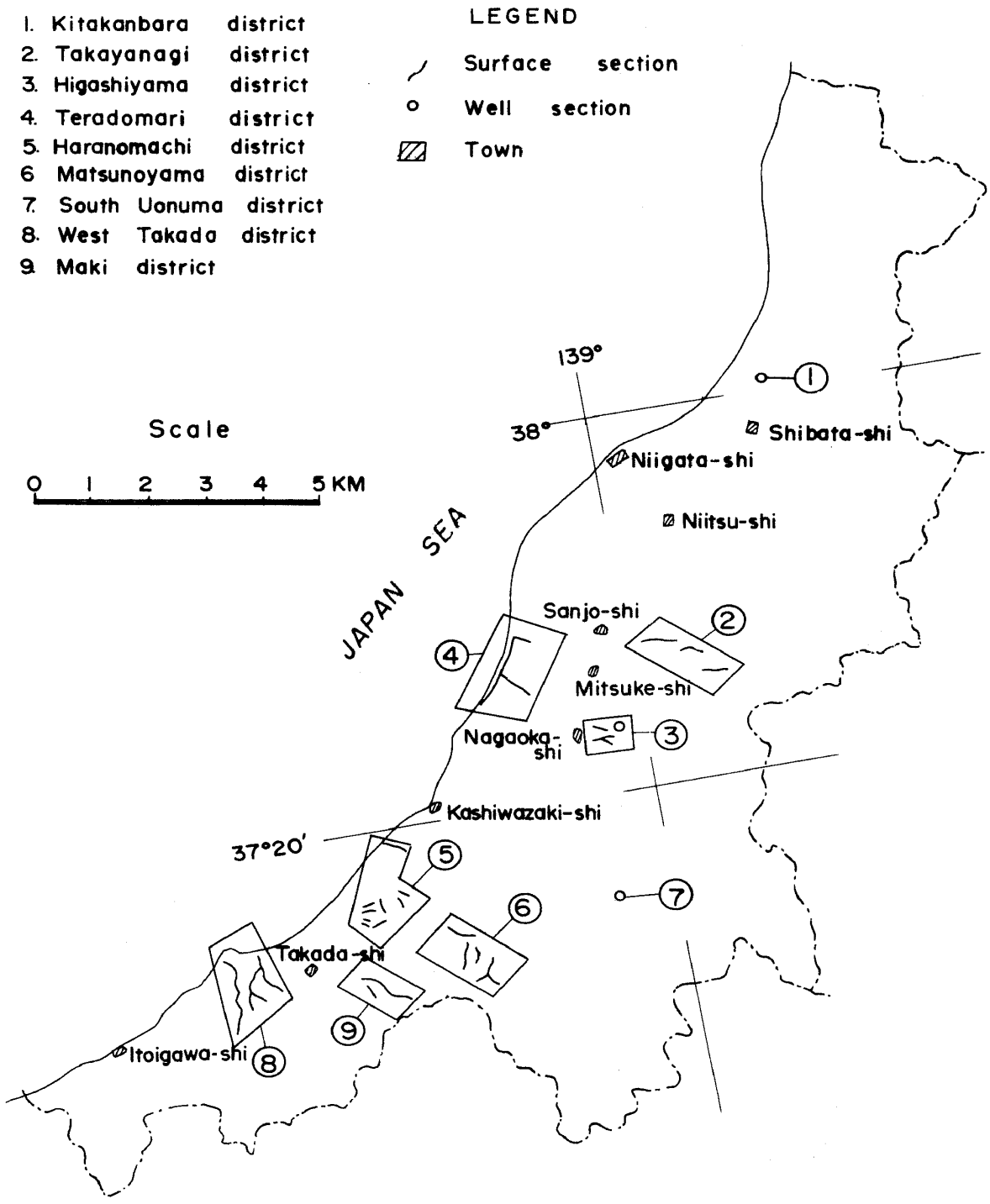


TABLE I

CHECK LIST SHOWING KNOWN STRATIGRAPHIC OCCURRENCE OF FORAMINIFERA AND ZONULES
IN
NORTH AKITA DISTRICT, AKITA PREFECTURE

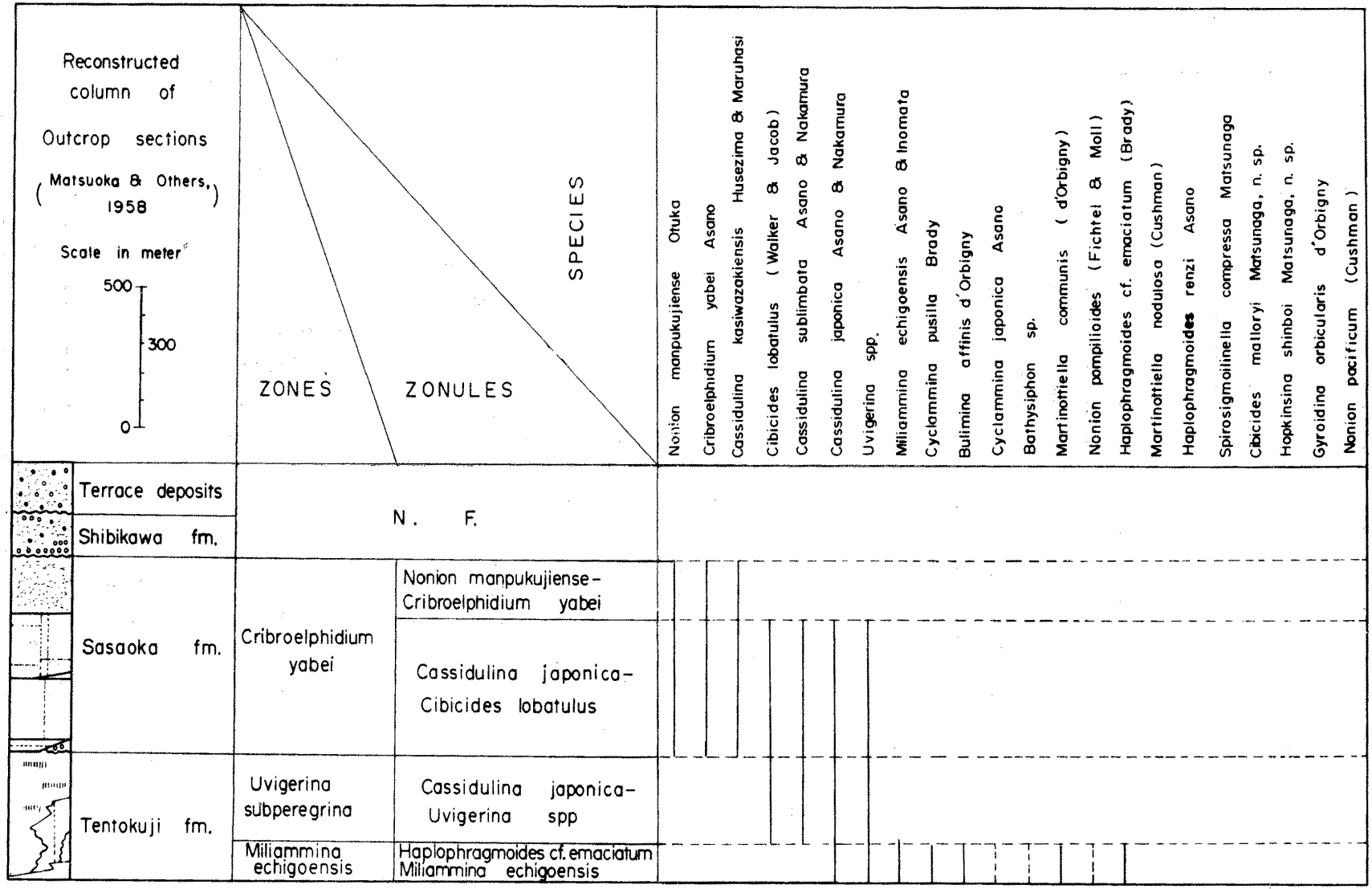
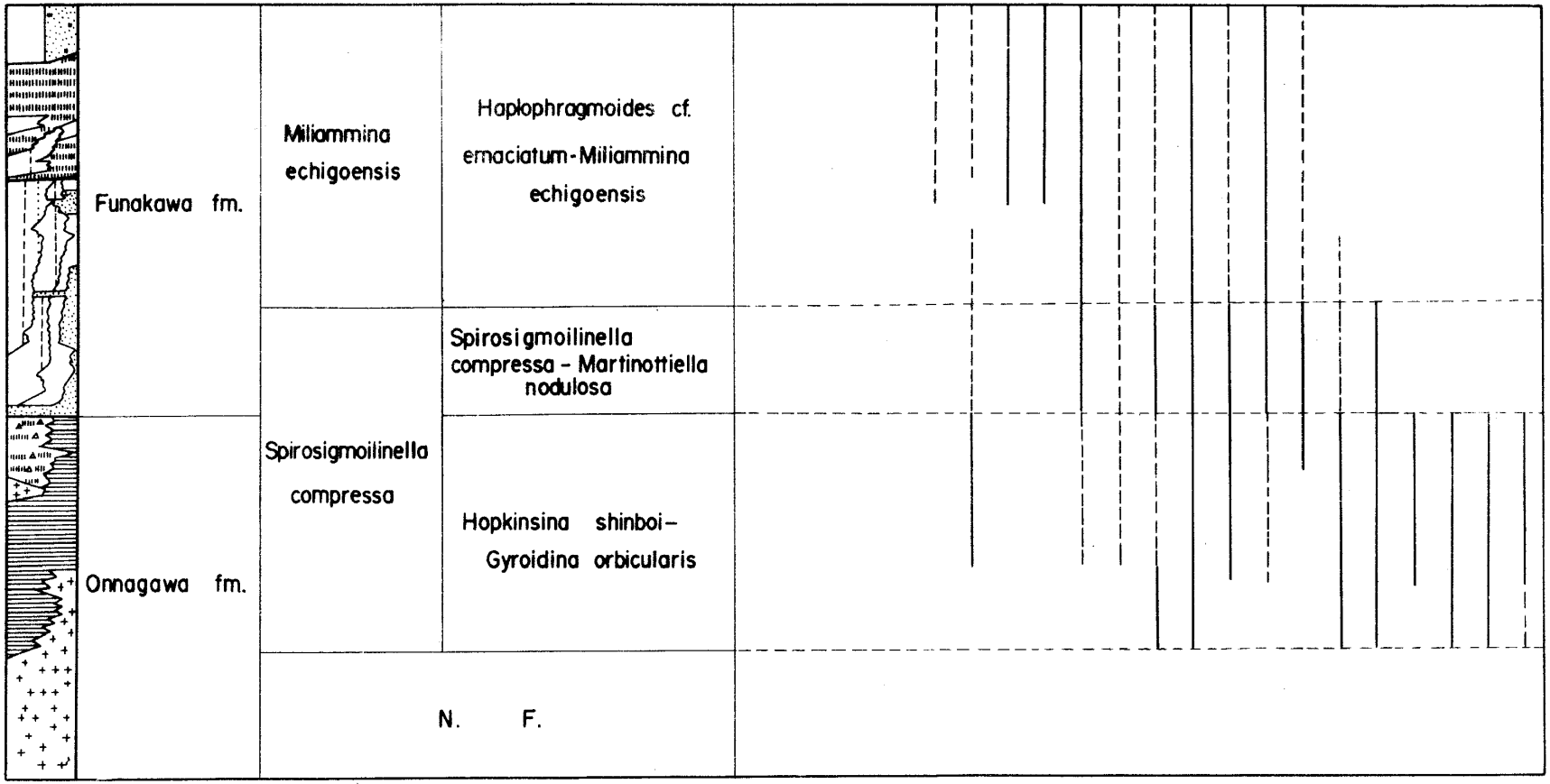


TABLE I (Continued)



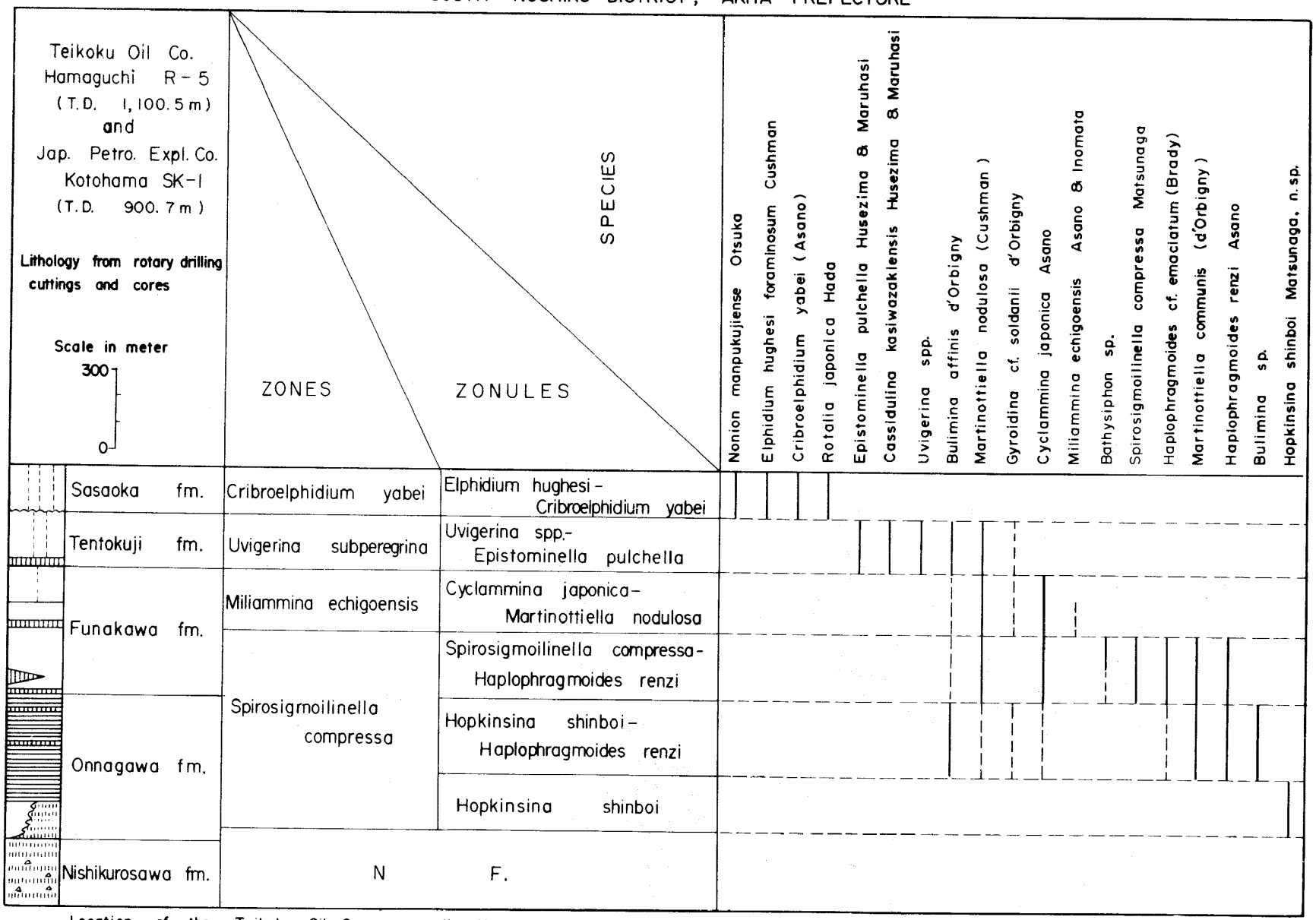

Localities : See "Register of localities"

LEGEND

Mudstone
Tuffaceous mudstone
Hard mudstone
Hard shale
Siltstone
Sandstone
Conglomerate
Tuff
Agglomerate
Igneous rocks
N. F. No foraminifera
R. F. Rare foraminifera
Abundant and Common
Scarce

TABLE 2

CHECK LIST SHOWING KNOWN STRATIGRAPHIC OCCURRENCE OF FORAMINIFERA AND ZONULES
IN
SOUTH NOSHIRO DISTRICT, AKITA PREFECTURE




Location of the Teikoku Oil Company well, Hamaguchi R-5 : Hamaguchi, Hachiryu-mura, Yamamoto-gun, Akita prefecture.
Location of the Japan Petroleum Exploration Company well, Kotohama SK-1 : Tsuchibana, Kotohama-mura, Minamiakita-gun, Akita prefecture.

TABLE 3

CHECK LIST SHOWING KNOWN STRATIGRAPHIC OCCURRENC OF FORAMINIFERA AND ZONULES
IN
OGA DISTRICT, AKITA PREFECTURE

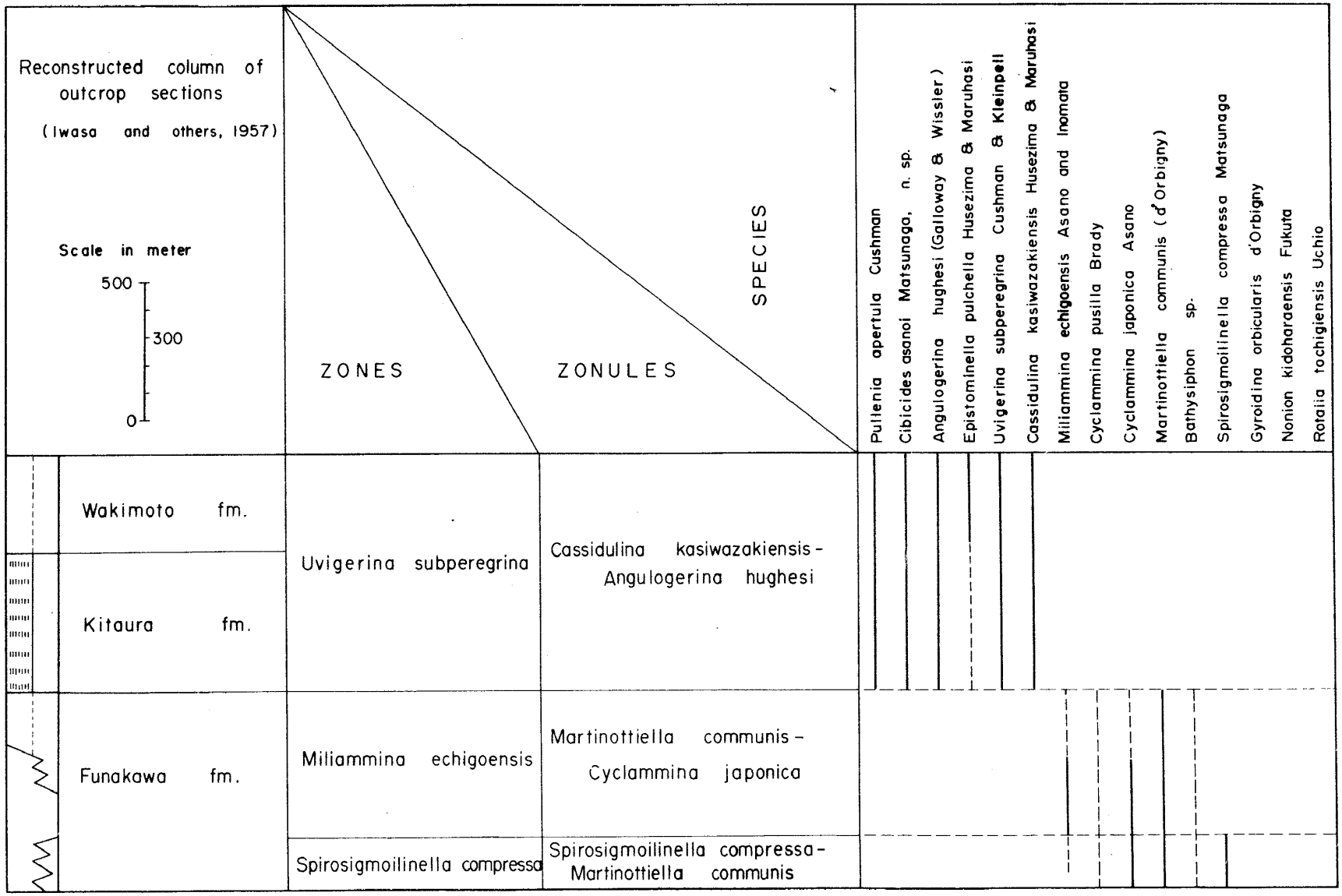


TABLE 3 (Continued)

| | | | |
|---|---|---|---|
| Funakawa fm. | Spirosigmoilinella compressa | Spirosigmoilinella compressa - Martinottiella communis | |
| Onnagawa fm. | | Bathysiphon sp. - Martinottiella communis | |
| Nishikurosawa fm. | Globorotalia cf. fohsi | Rotalia tochigiensis - Nonion kidohara. | |
| Daijima fm. | N. | F. | |

Localities : See "Register of Localities"

TABLE 4

CHECK LIST SHOWING KNOWN STRATIGRAPHIC OCCURRENCE OF FORAMINIFERA AND ZONULES

IN

WADA DISTRICT, AKITA PREFECTURE

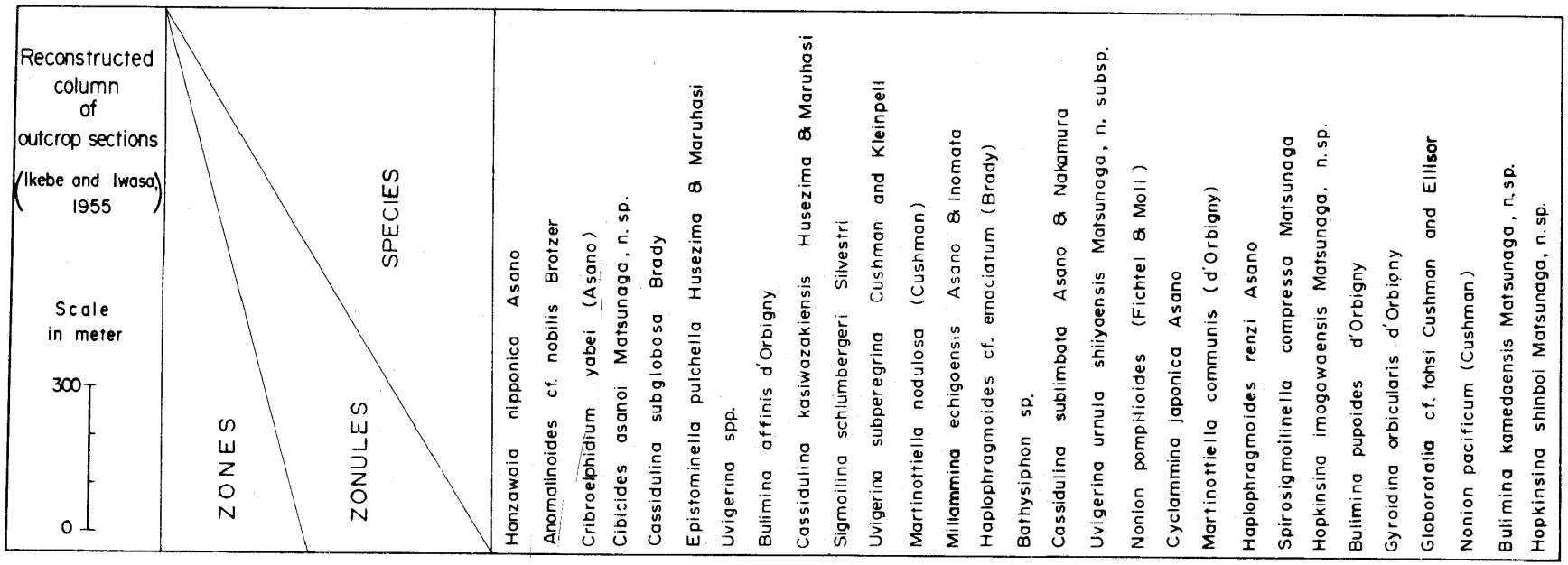


TABLE 4 (Continued)

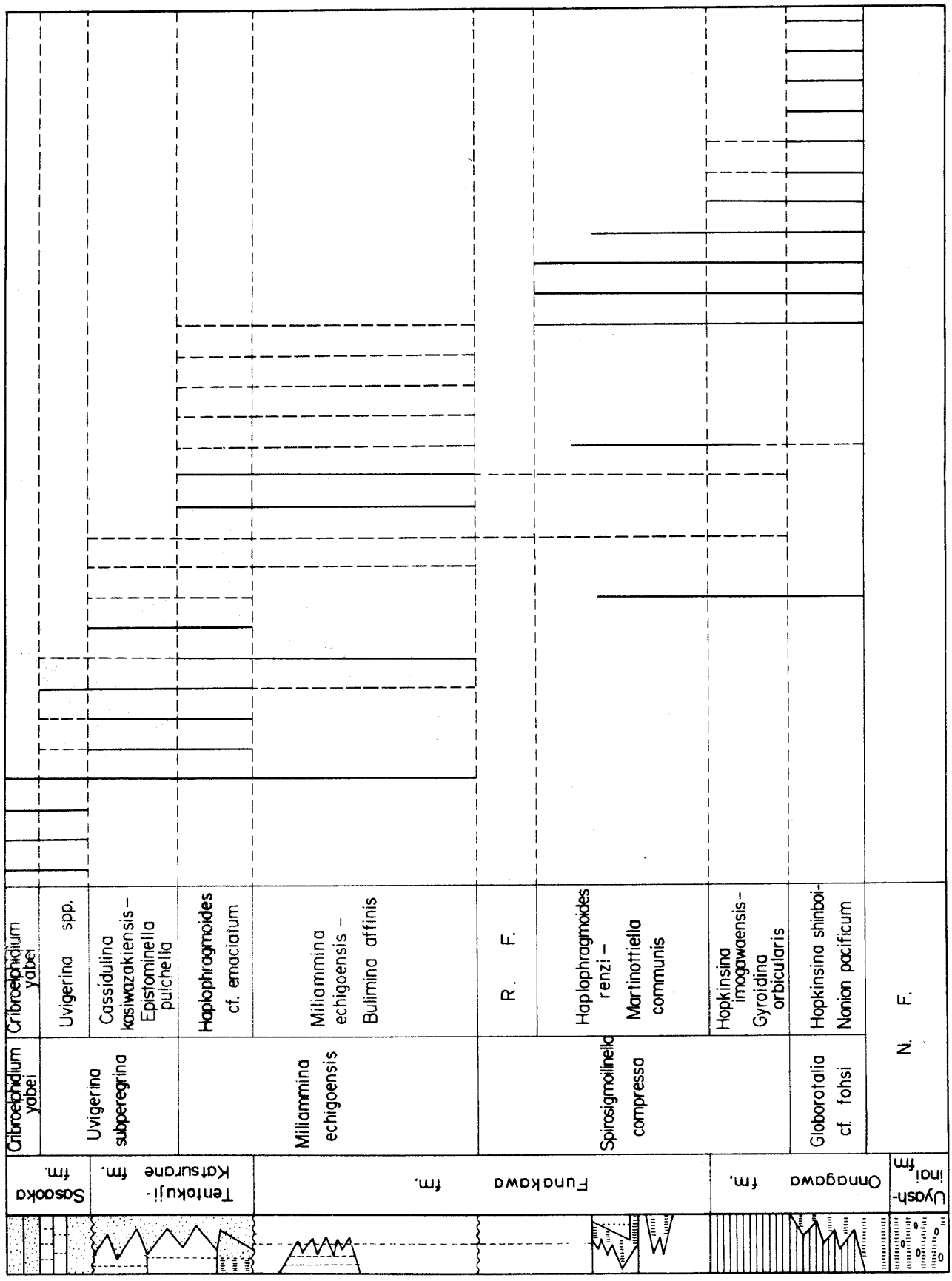


TABLE 5

CHECK LIST SHOWING KNOWN STRATIGRAPHIC OCCURRENCE OF FORAMINIFERA AND ZONULES
IN
YURI DISTRICT, AKITA PREFECTURE

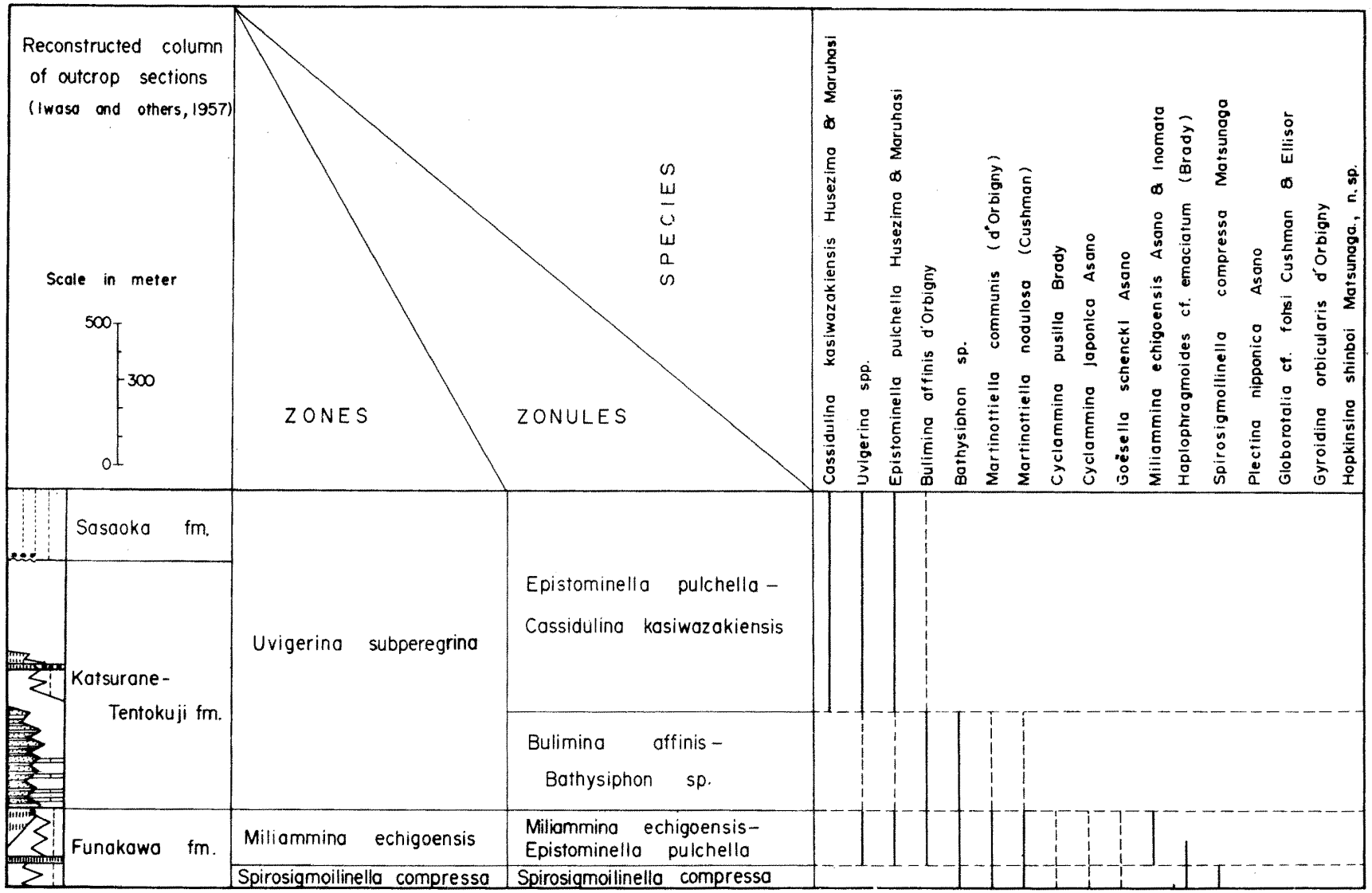


TABLE 5 (Continued)

| | | | |
|---|---|---|---|
| Funakawa fm. | Spirosigmoilinella Compressa | Spirosigmoilimella compressa | |
| Onnagawa fm. | | Plectina nipponica – Spirosigmoilinella compressa | |
| | Globorotalia cf. fohsi | Hopkinsina shinboi – Gyroidina orbicularis | |
| Uyashinai–Sunakobuchi fm. | N. F. | | |

Localities : See "Register of localities"

TABLE 6

CHECK LIST SHOWING KNOWN STRATIGRAPHIC OCCURRENCE OF FORAMINIFERA AND ZONULES IN YAJIMA DISTRICT, AKITA PREFECTURE

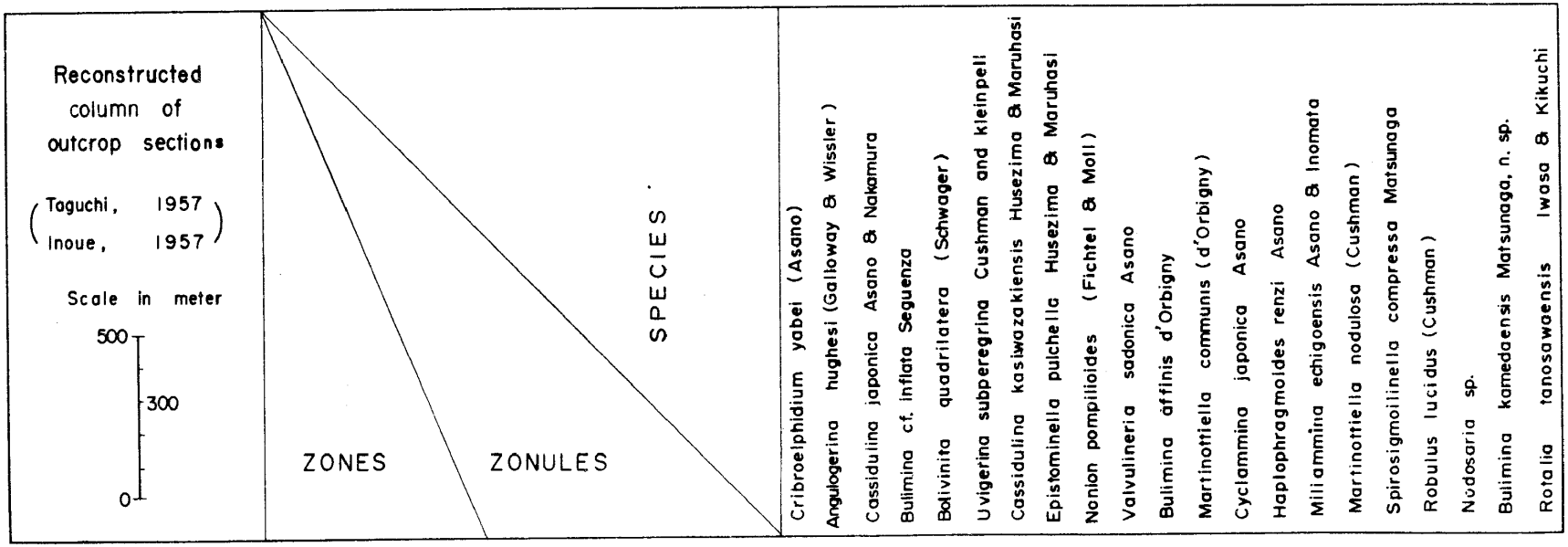
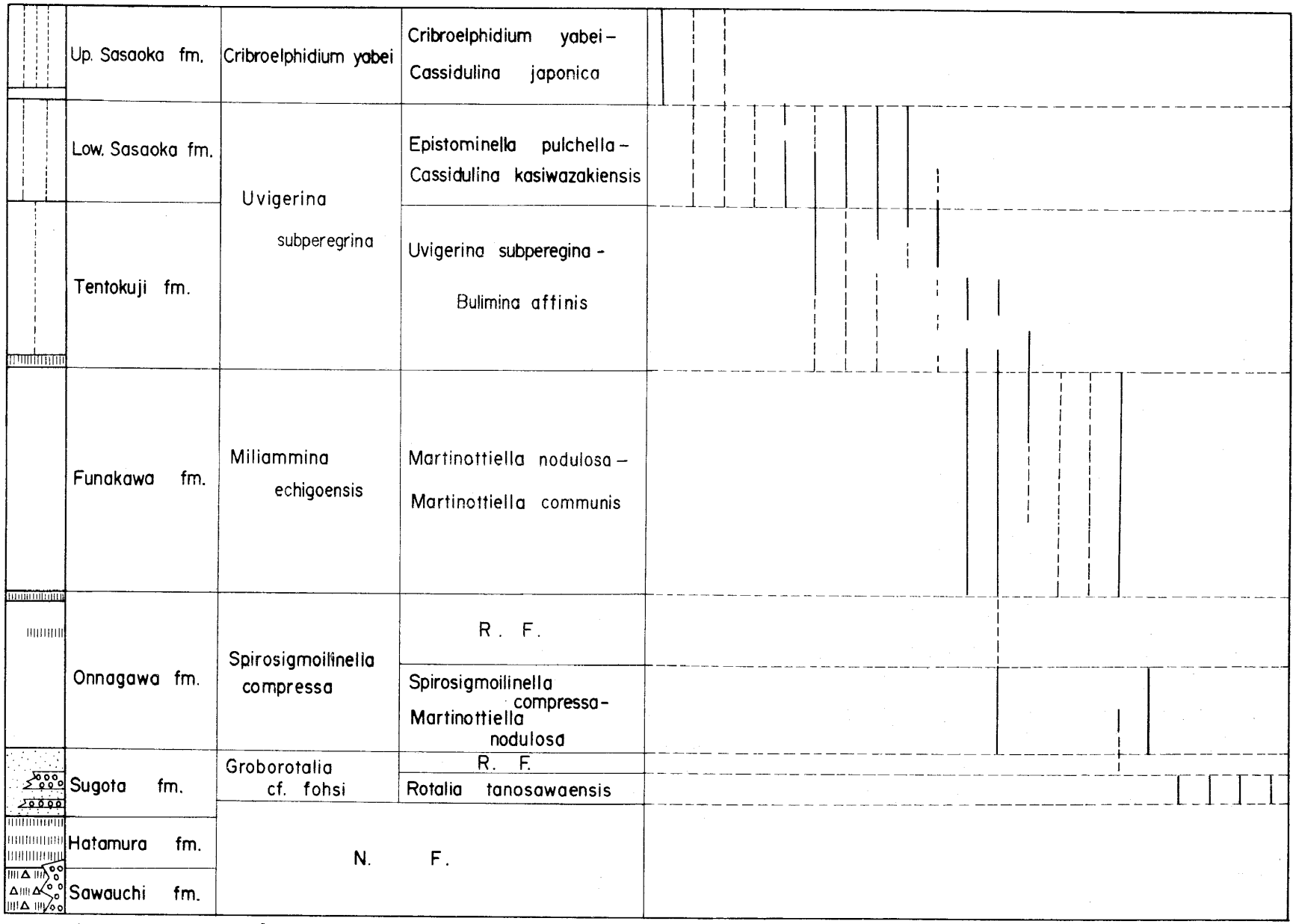


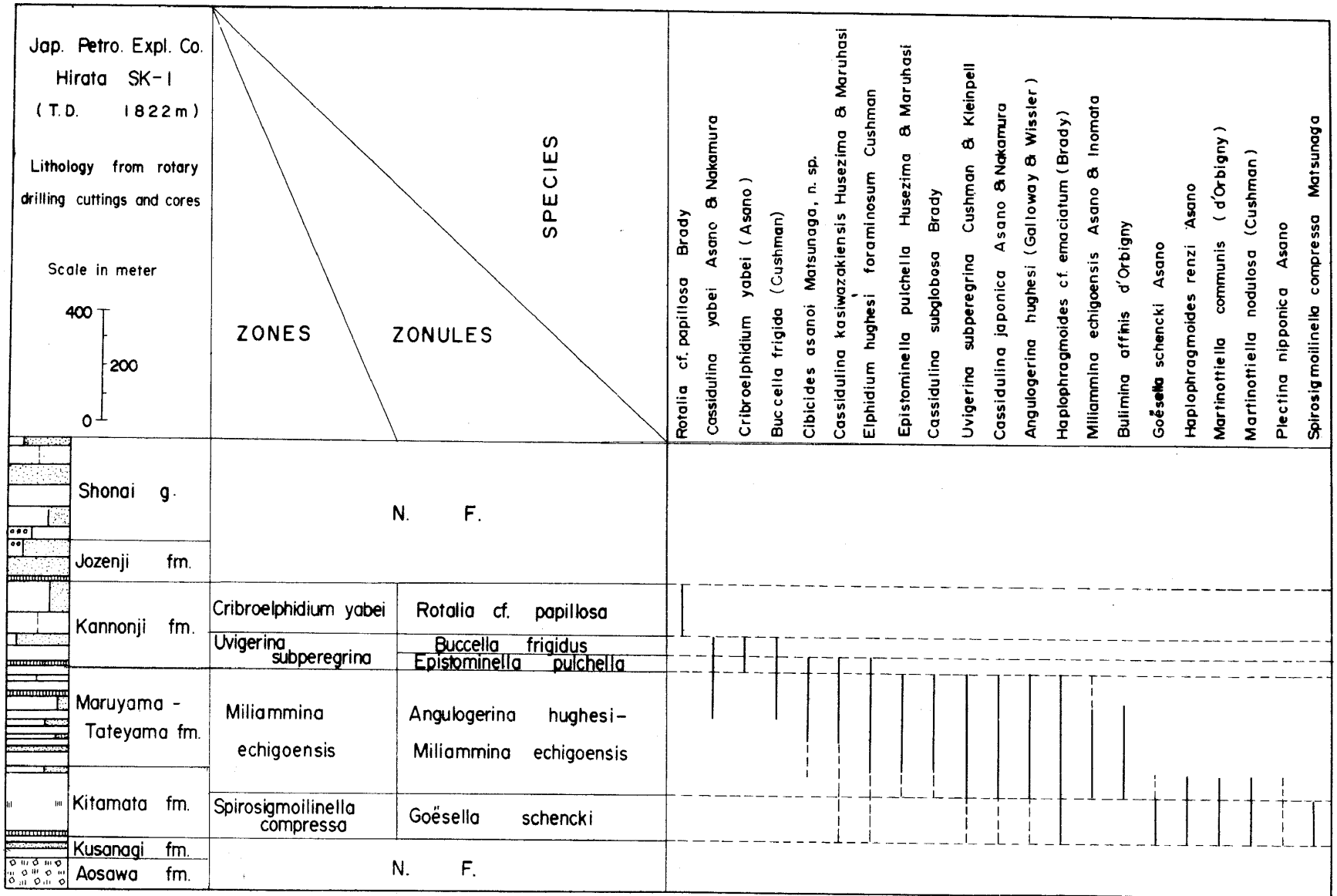
TABLE 6 ( Continued )




Localities : See "Register of localities."

TABLE 7

CHECK LIST SHOWING KNOWN STRATIGRAPHIC OCCURRENCE OF FORAMINIFERA AND ZONULES
IN
EAST SAKATA DISTRICT, YAMAGATA PREFECTURE



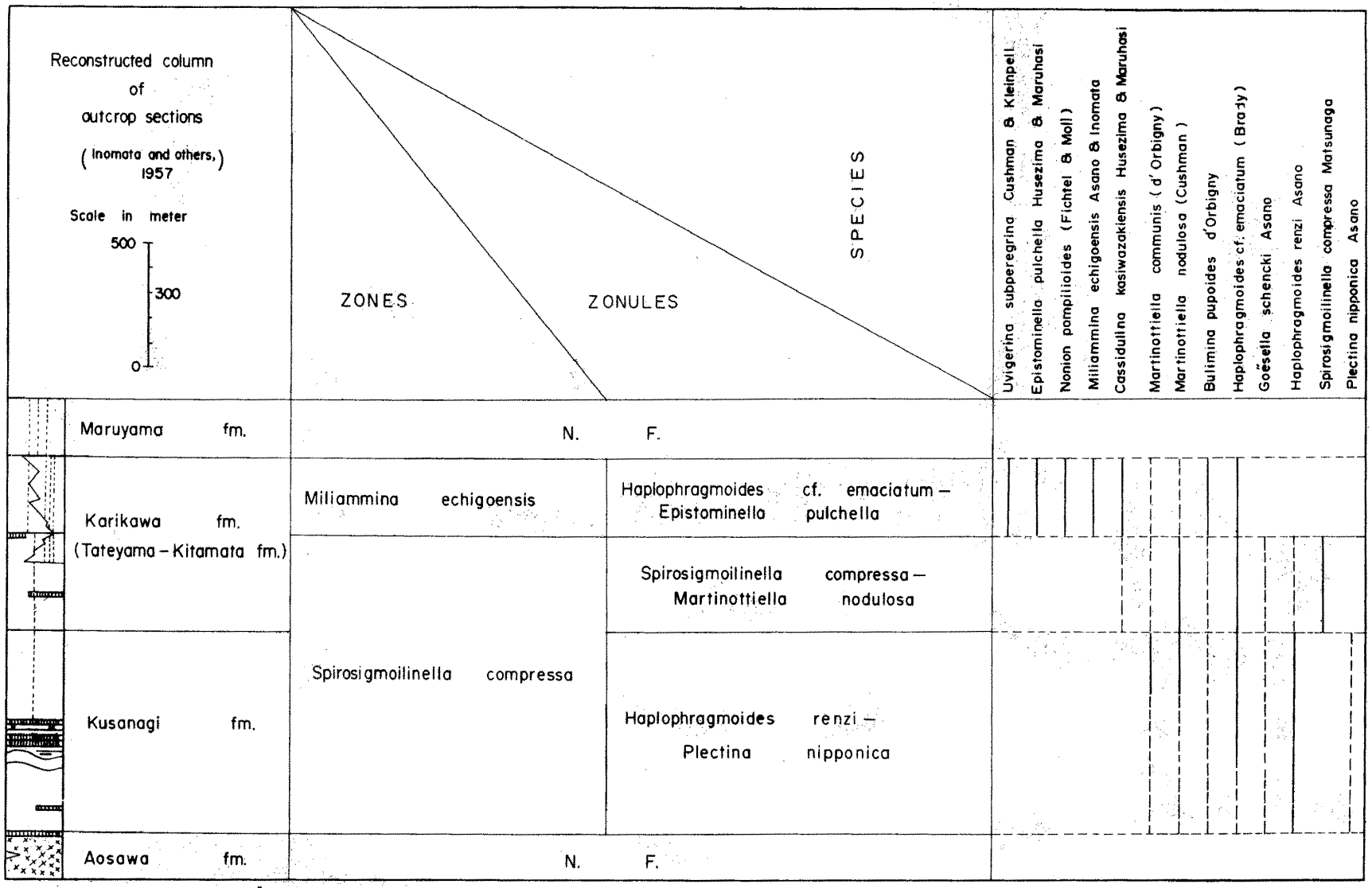

Location of the Japan Petroleum Exploration Company well, Hirata SK-1 : Ohira, Higashihirata, Sakata-shi, Yamagata prefecture

TABLE 8

CHECK LIST SHOWING KNOWN STRATIGRAPHIC OCCURRENCE OF FORAMINIFERA AND ZONULES

IN

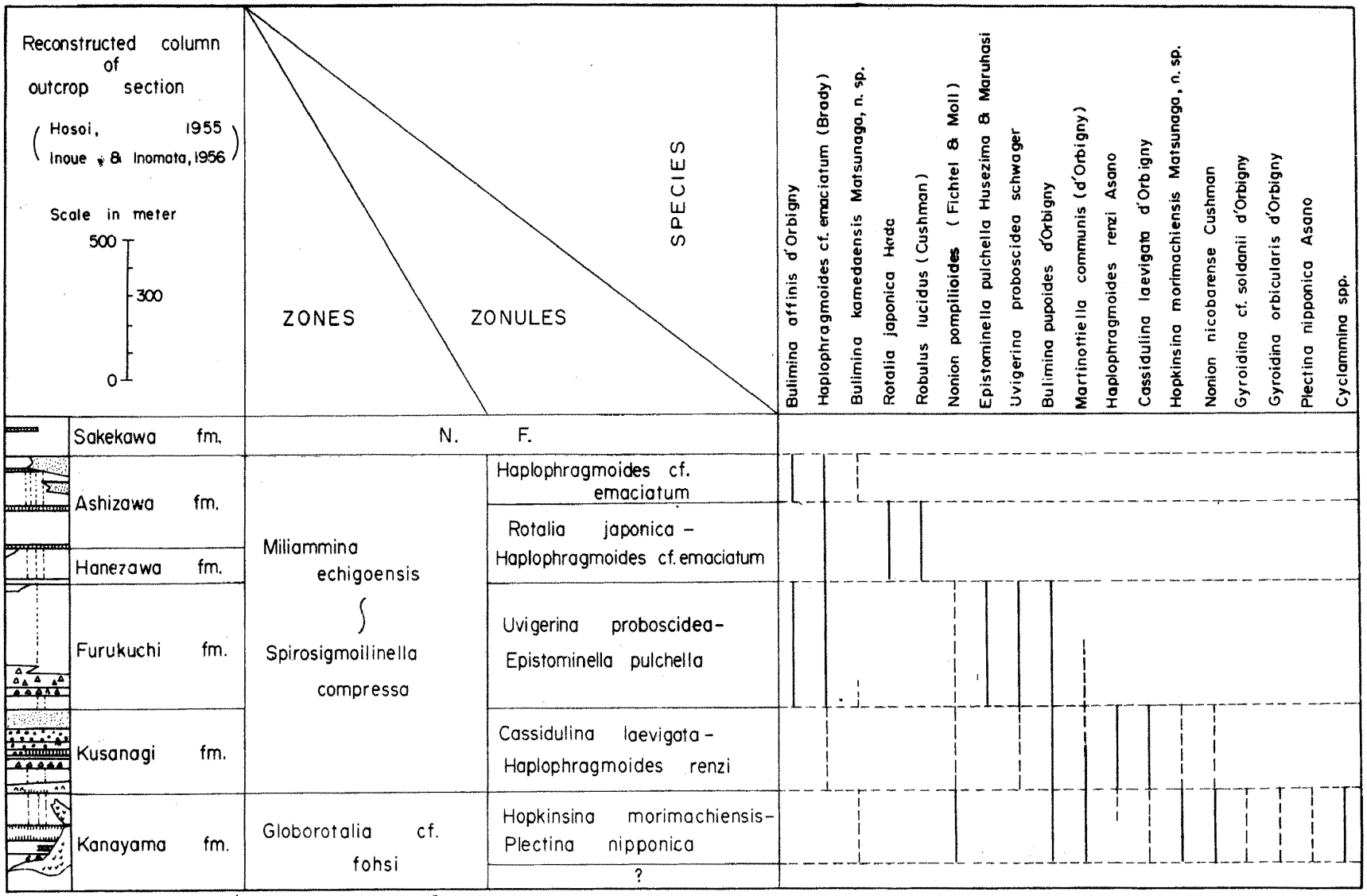
KARIKAWA DISTRICT, YAMAGATA PREFECTURE




Localities : See "Register of localities"

TABLE 9

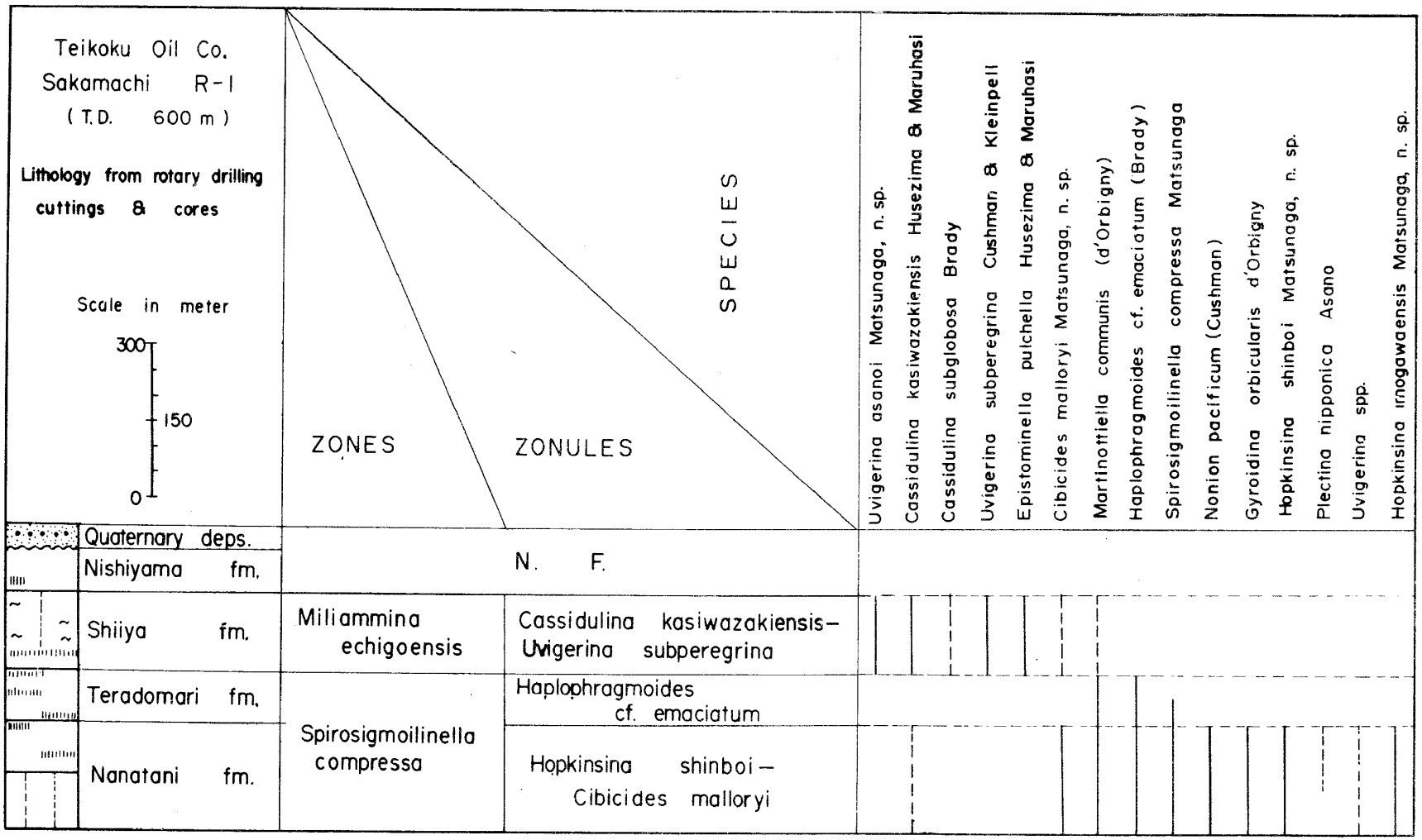
CHECK LIST SHOWING KNOWN STRATIGRAPHIC OCCURRENCE OF FORAMINIFERA AND ZONULES
IN
NORTH SHINJYO DISTRICT, YAMAGATA PREFECTURE




Localities : See "Register of locatities"

TABLE 10

CHECK LIST SHOWING KNOWN STRATIGRAPHIC OCCURRENCE OF FORAMINIFERA AND ZONULES
IN
KITAKANBARA DISTRICT, NIIGATA PREFECTURE




Location of the Teikoku Oil Company well, Sakamachi R-1 : Sakamachi, Honai-mura, Iwafune-gun, Niigata prefecture.

TABLE 11

CHECK LIST SHOWING KNOWN STRATIGRAPHIC OCCURRENCE OF FORAMINIFERA AND ZONULES
IN
TAKAYANAGI DISTRICT, NIIGATA PREFECTURE

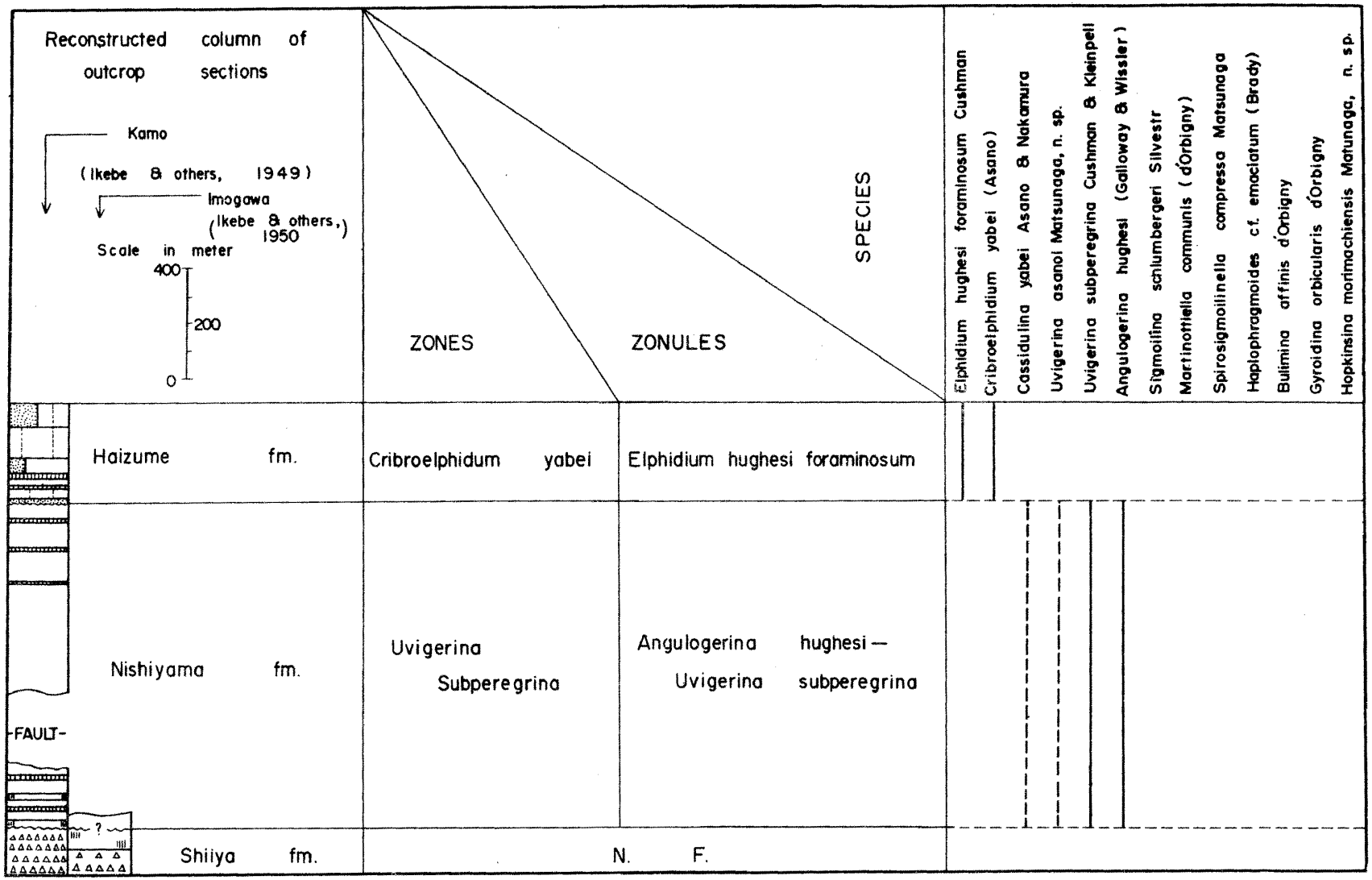
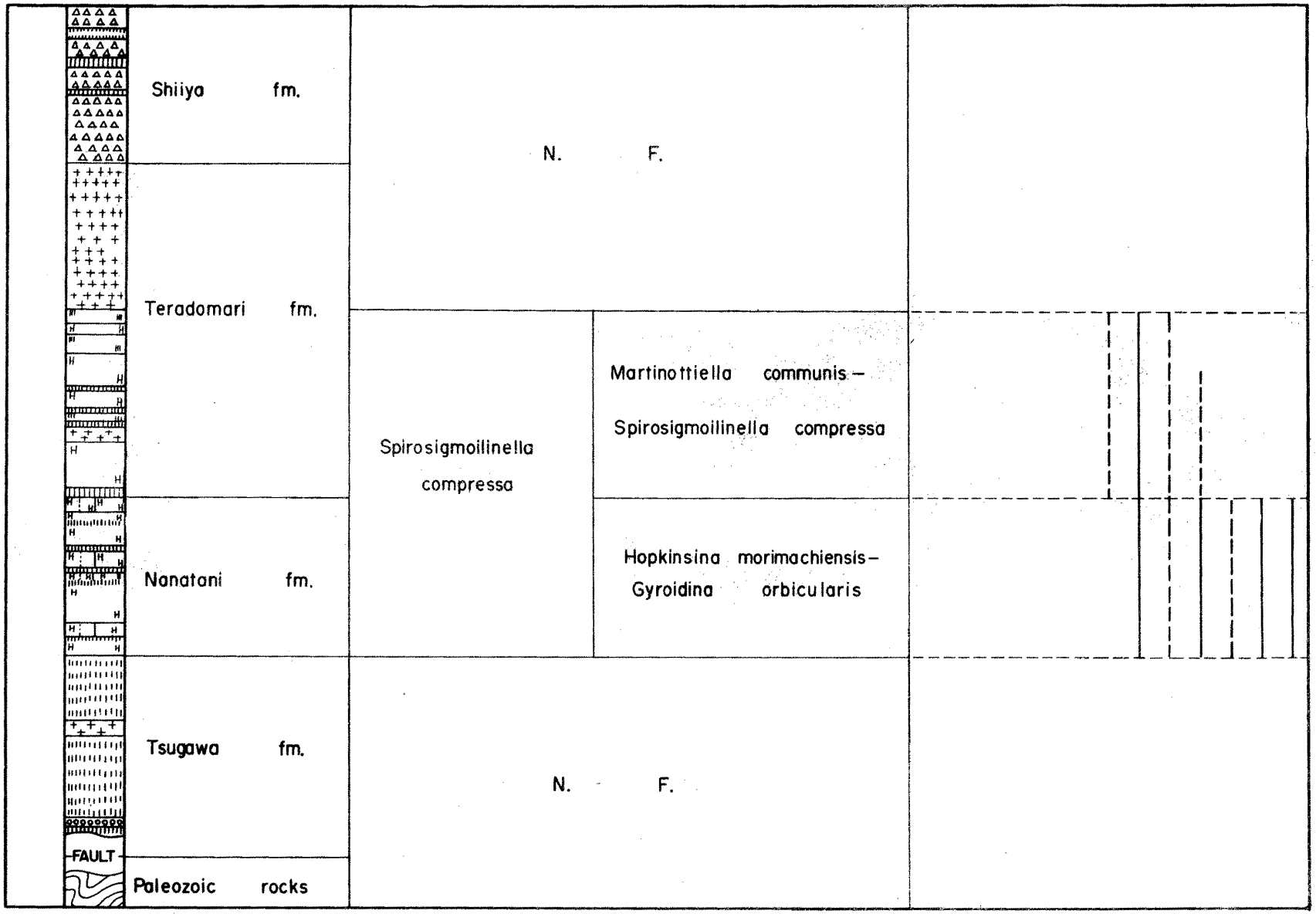


TABLE II ( Contineud )




Localities : See "Register of localities"

TABLE 12

CHECK LIST SHOWING KNOWN STRATIGRAPHIC OCCURRENCE OF FORAMINIFERA AND ZONULES
IN
HIGASHIYAMA DISTRICT, NIIGATA PREFECTURE

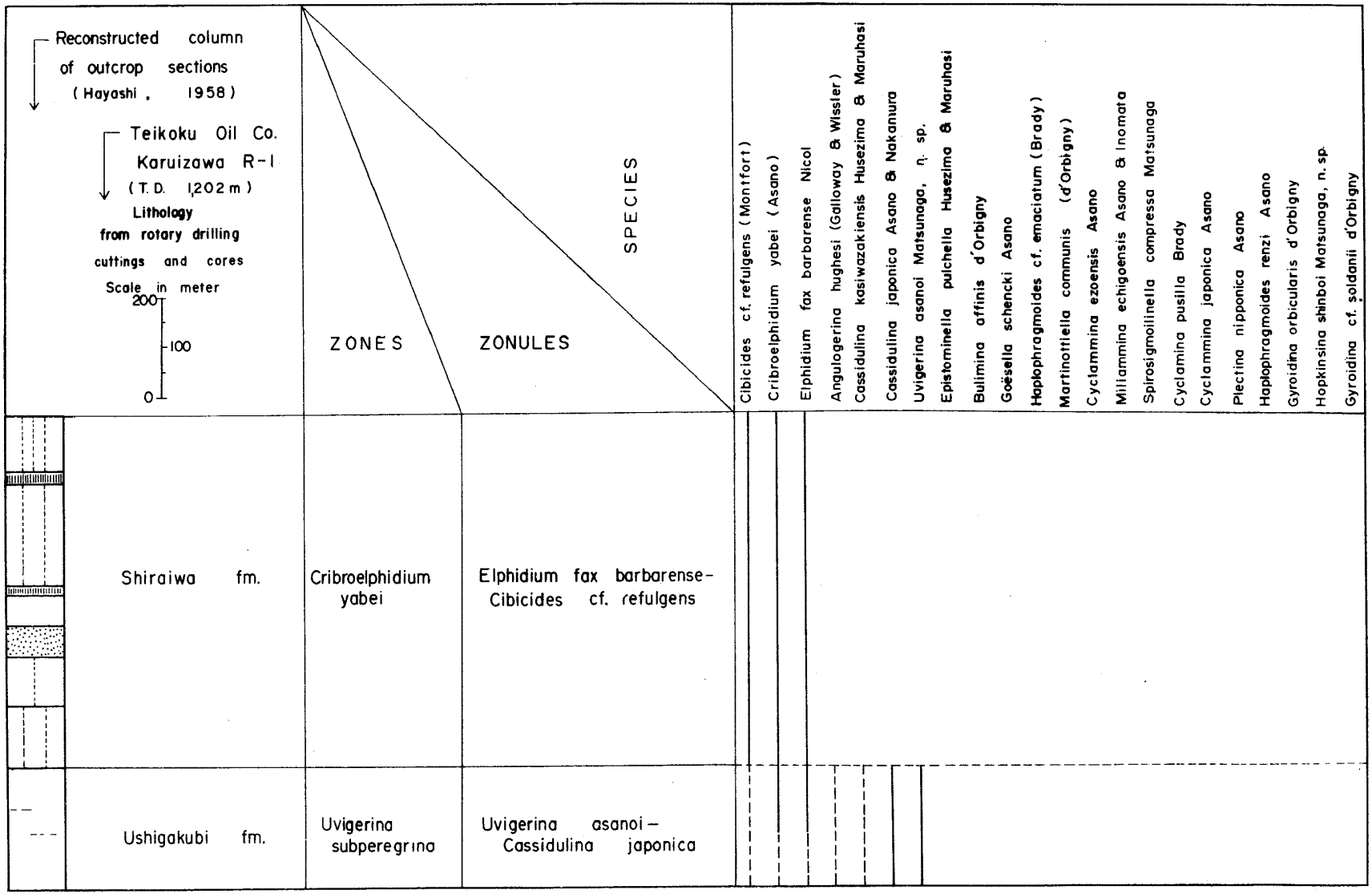
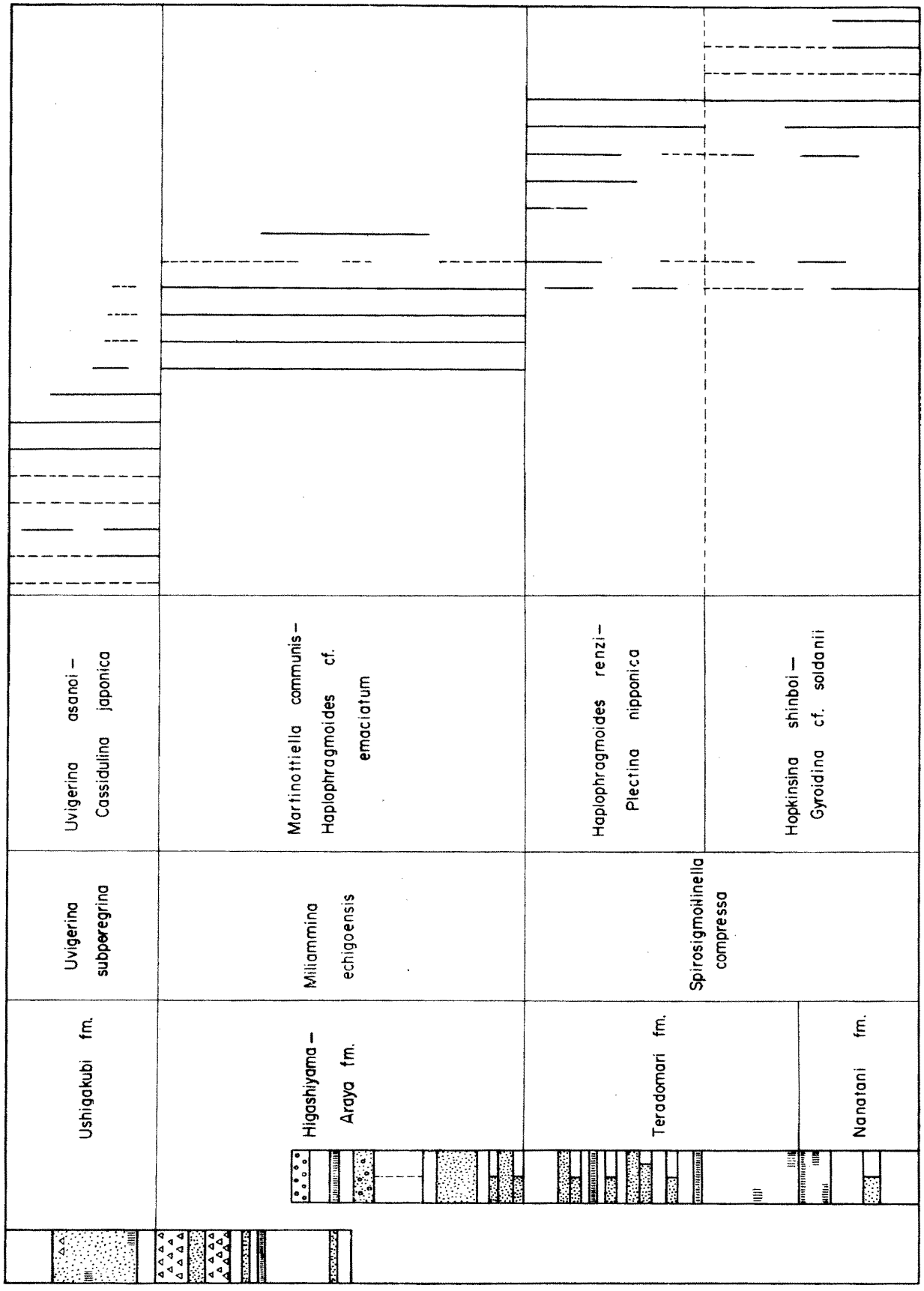


TABLE 12 (Continued)




Localities : See "Register of localities"

Location of the Teikoku Oil Company well, Karuizawa R-1 : Karuizawa, Tochio-shi, Niigata prefecture

# TABLE 13

## CHECK LIST SHOWING KNOWN STRATIGRAPHIC OCCURRENCE OF FORAMINIFERA AND ZONULES IN TERADOMARI DISTRICT, NIIGATA PREFECTURE

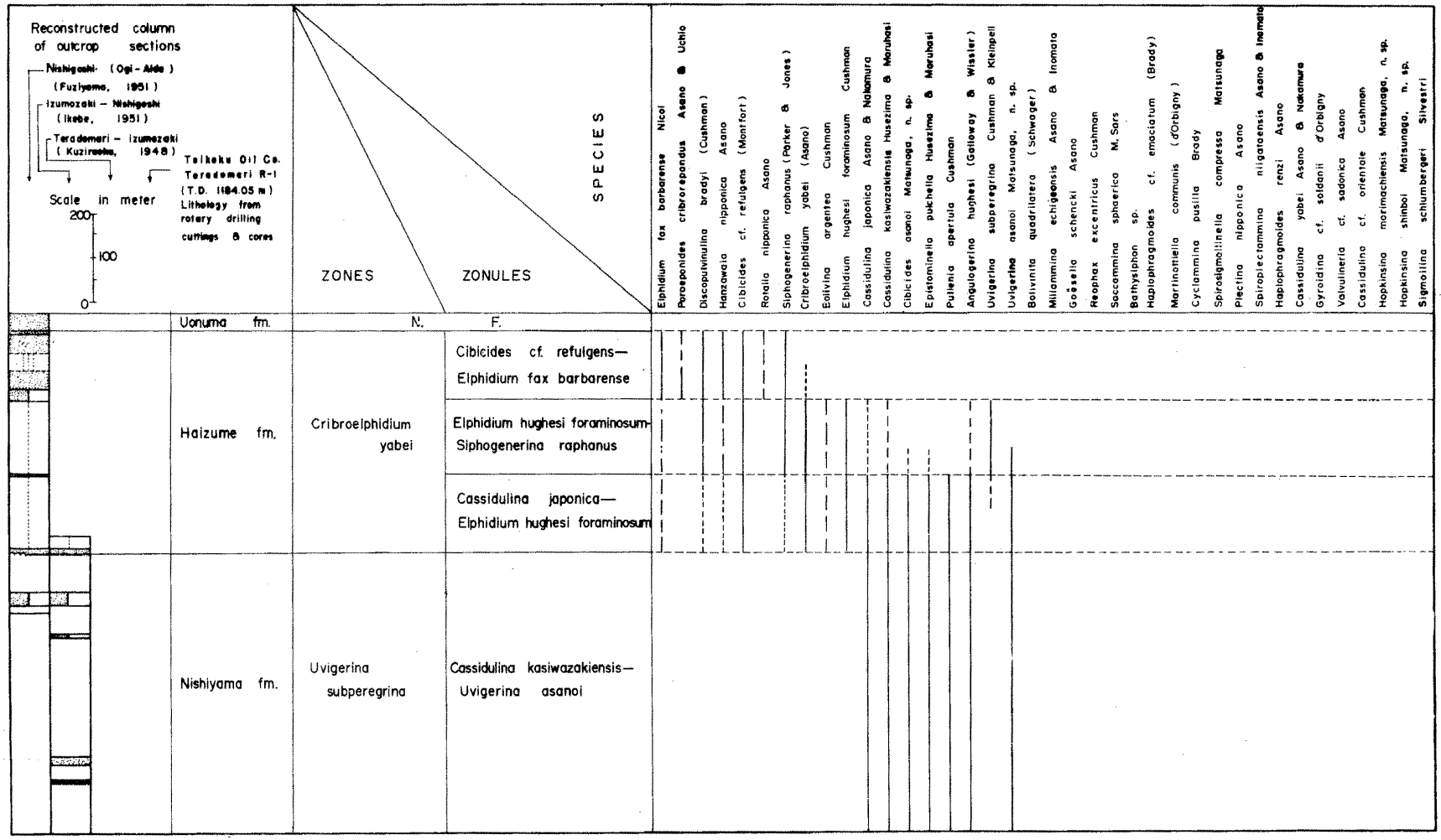
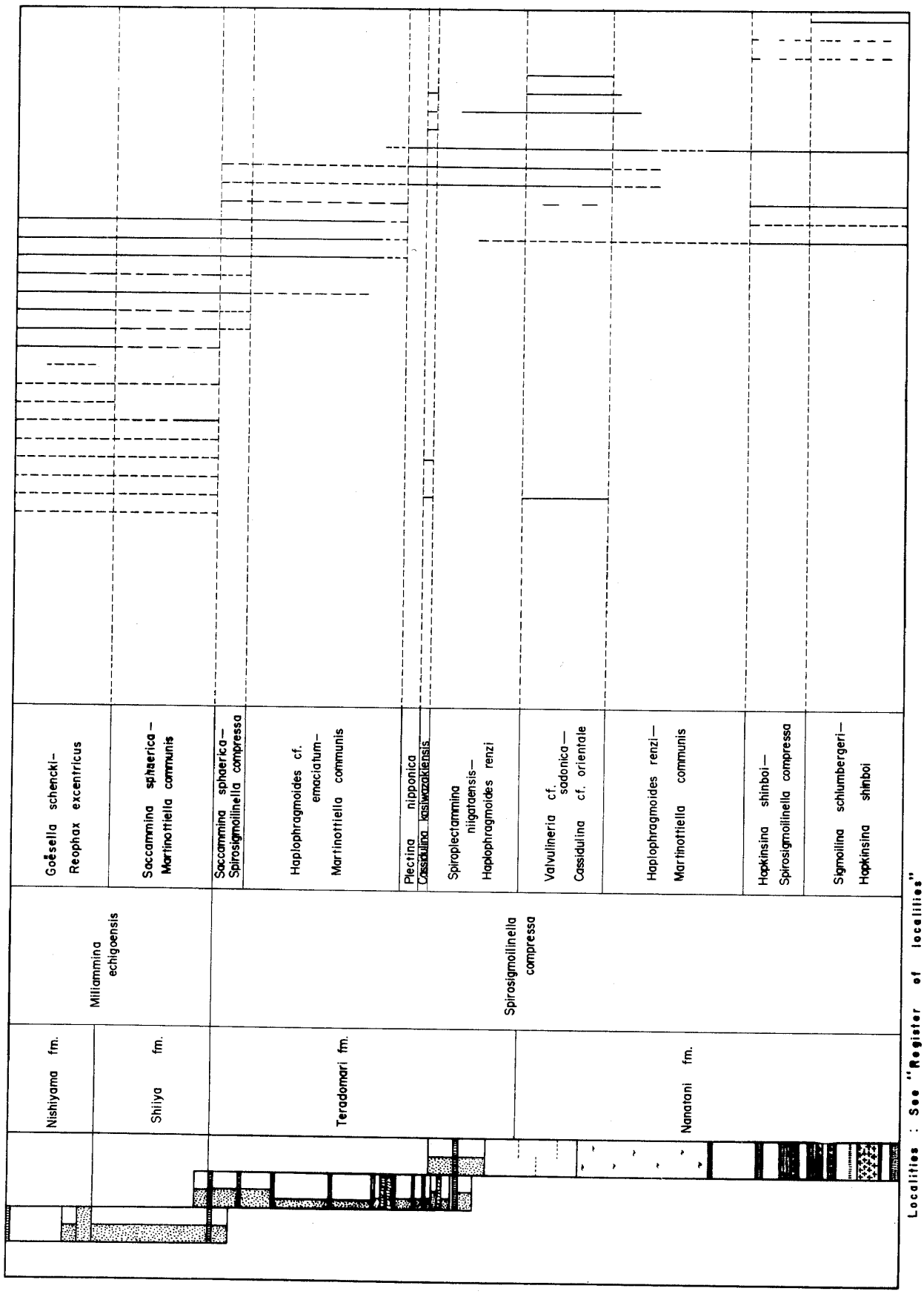


TABLE 13 (Continued)

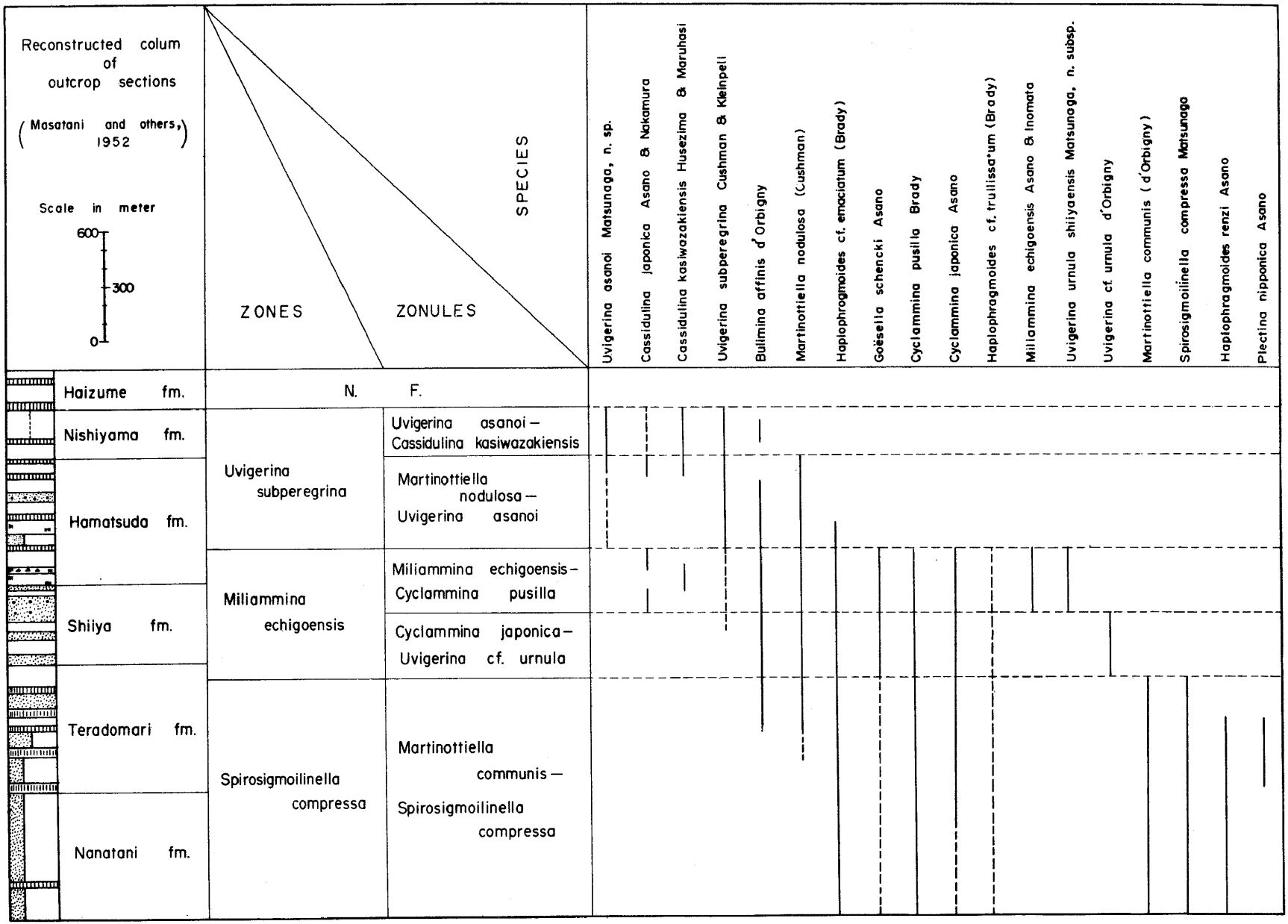



Localities : See "Register of localities"

Location of the Teikoku Oil Company well, Teradomari R-1 ; Teradoma, Teradomari-machi, Santo-gun, Niigata prefecture

TABLE 14

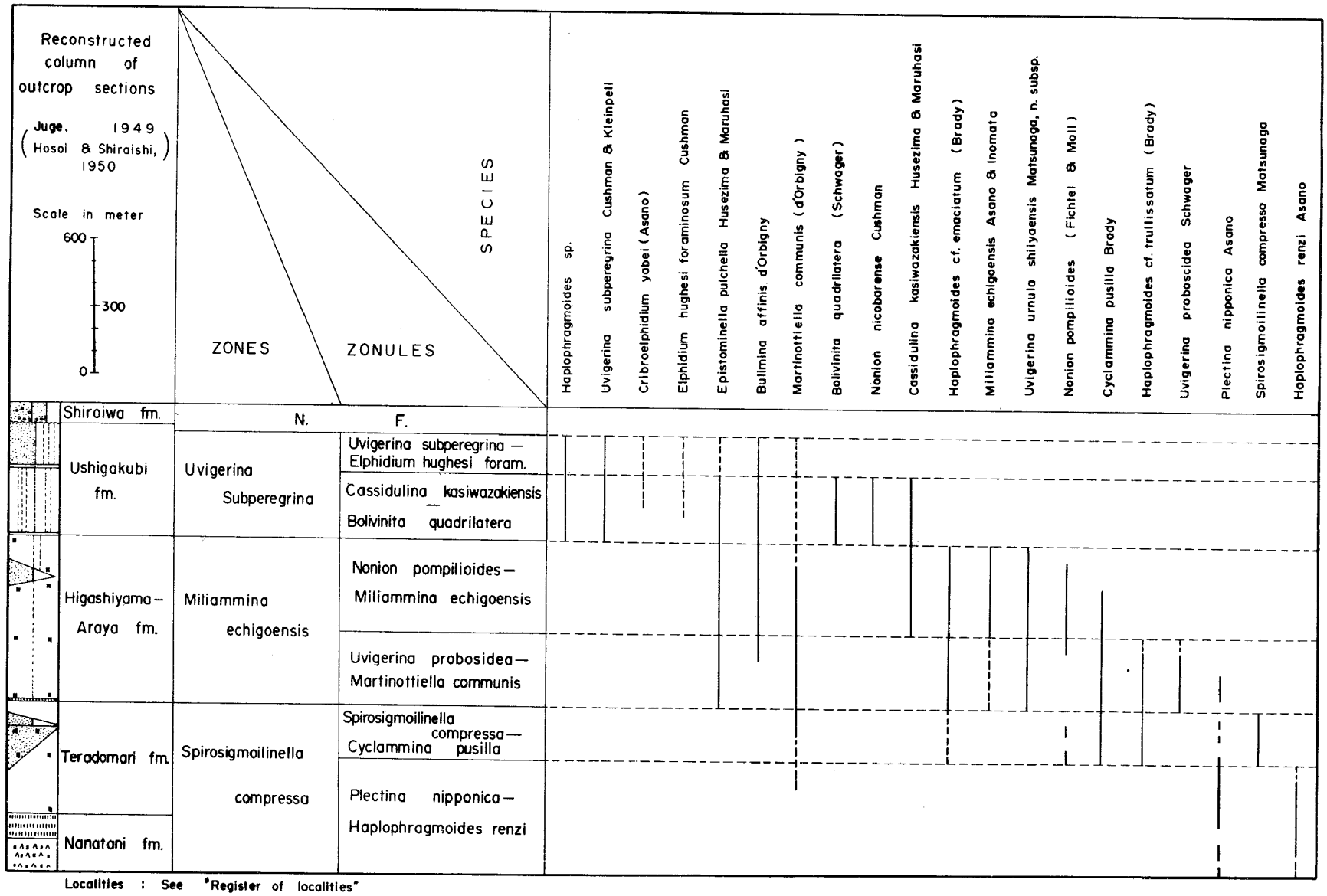
CHECK LIST SHOWING KNOWN STRATIGRAPHIC OCCURRENCE OF FORAMINIFERA AND ZONULES IN HARANOMACHI DISTRICT, NIIGATA PREFECTURE




Localities : See "Register of localities"

TABLE 15

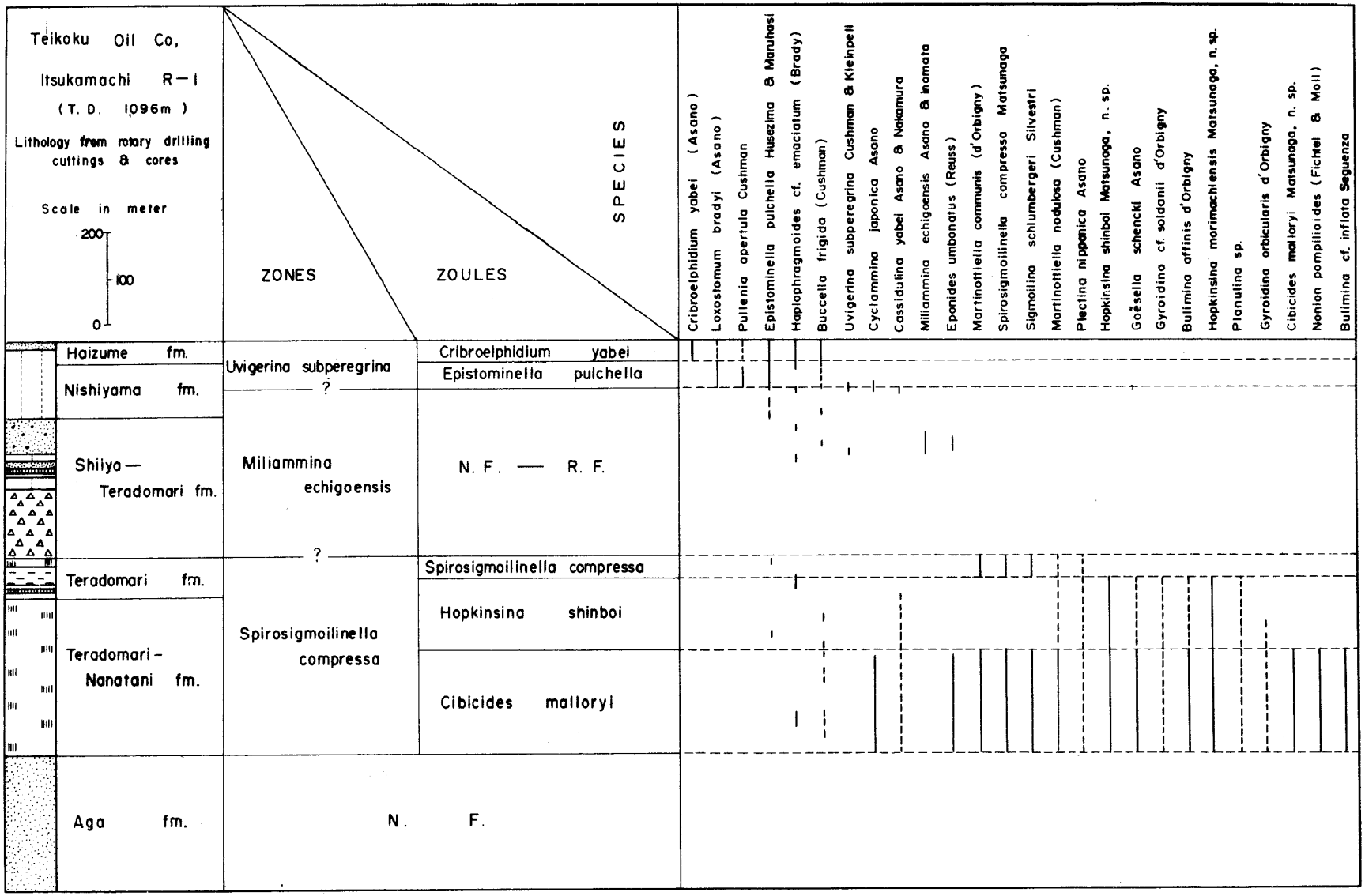
CHECK LIST SHOWING KNOWN STRATIGRAPHIC OCCURRENCE OF FORAMINIFERA AND ZONULES IN MATSUNOYAMA DISTRICT, NIIGATA PREFECTURE




Localities : See "Register of localities"

TABLE 16

CHECK LIST SHOWING KNOWN STRATIGRAPHIC OCCURRENCE OF FORAMINIFERA AND ZONULES IN SOUTH UONUMA DISTRICT, NIIGATA PREFECTURE




Location of the Teikoku Oil Company well, Itsukamachi R-1 : Nagizawa, Yamato-mura, Minami-uonuma-gun, Nigata prefecture.

TABLE 17

CHECK LIST SHOWING KNOWN STRATIGRAPHIC OCCURRENCE OF FORAMINIFERA AND ZONULES

IN

WEST TAKADA DISTRICT, NIIGATA PREFECTURE

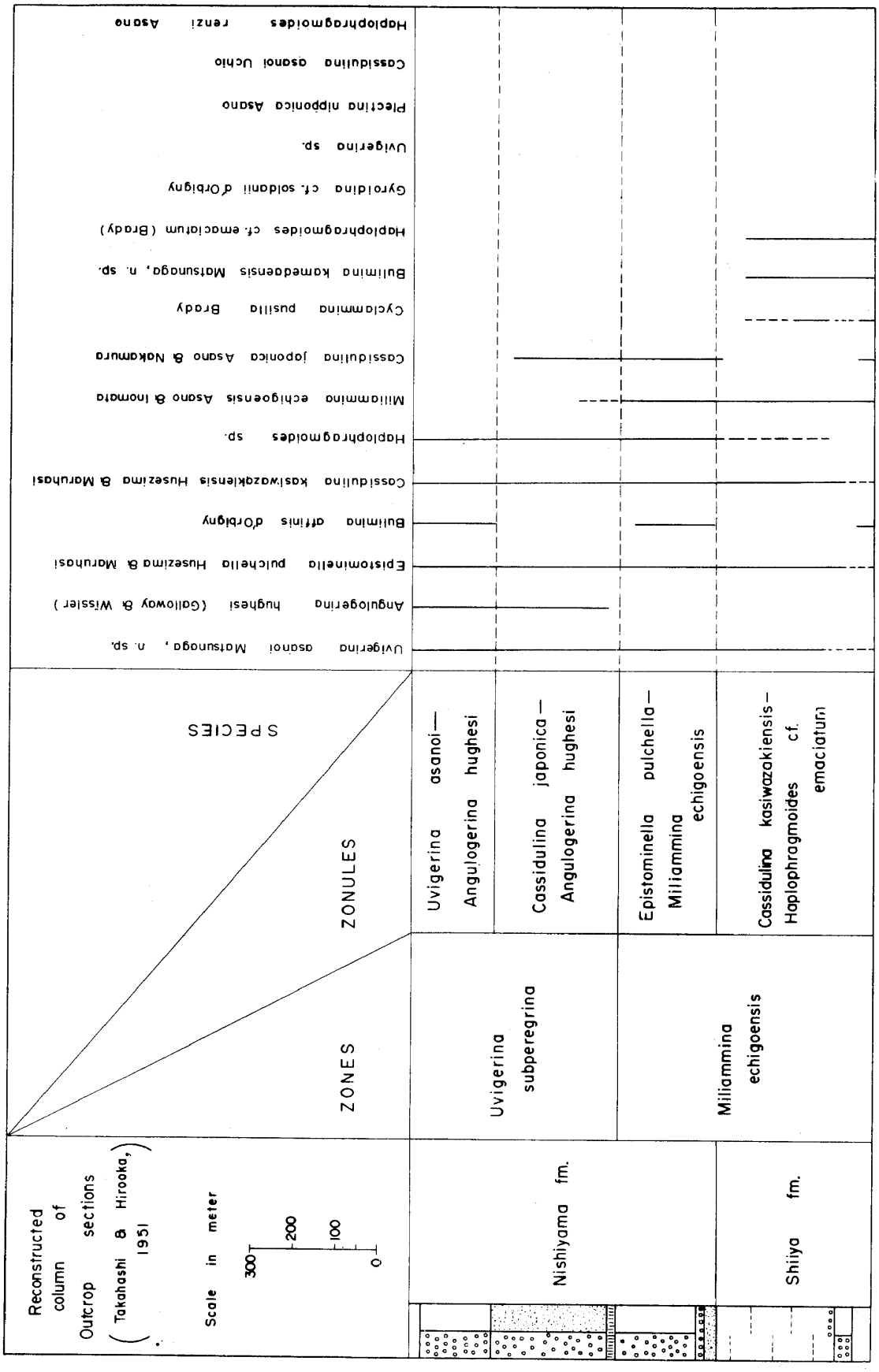
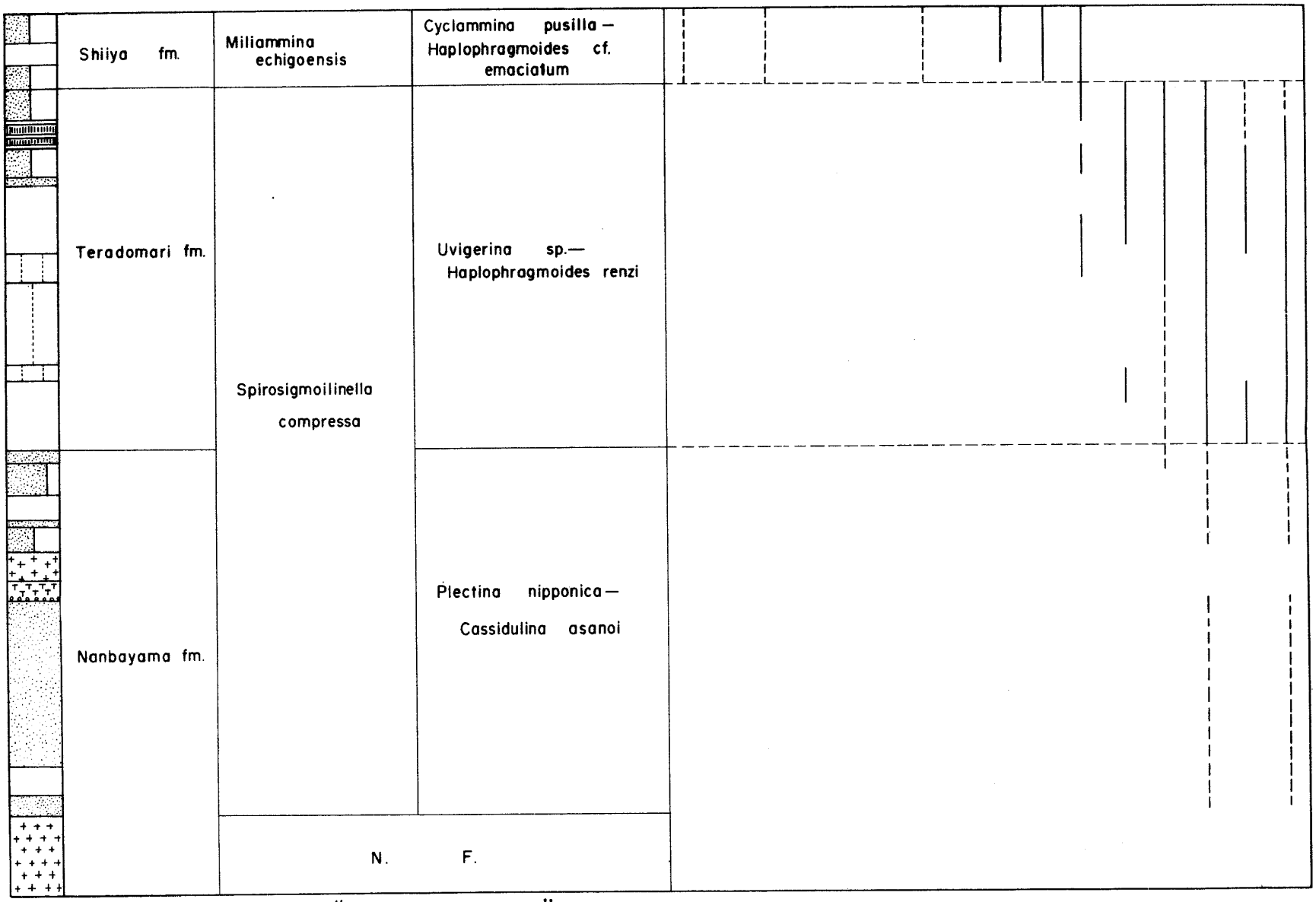


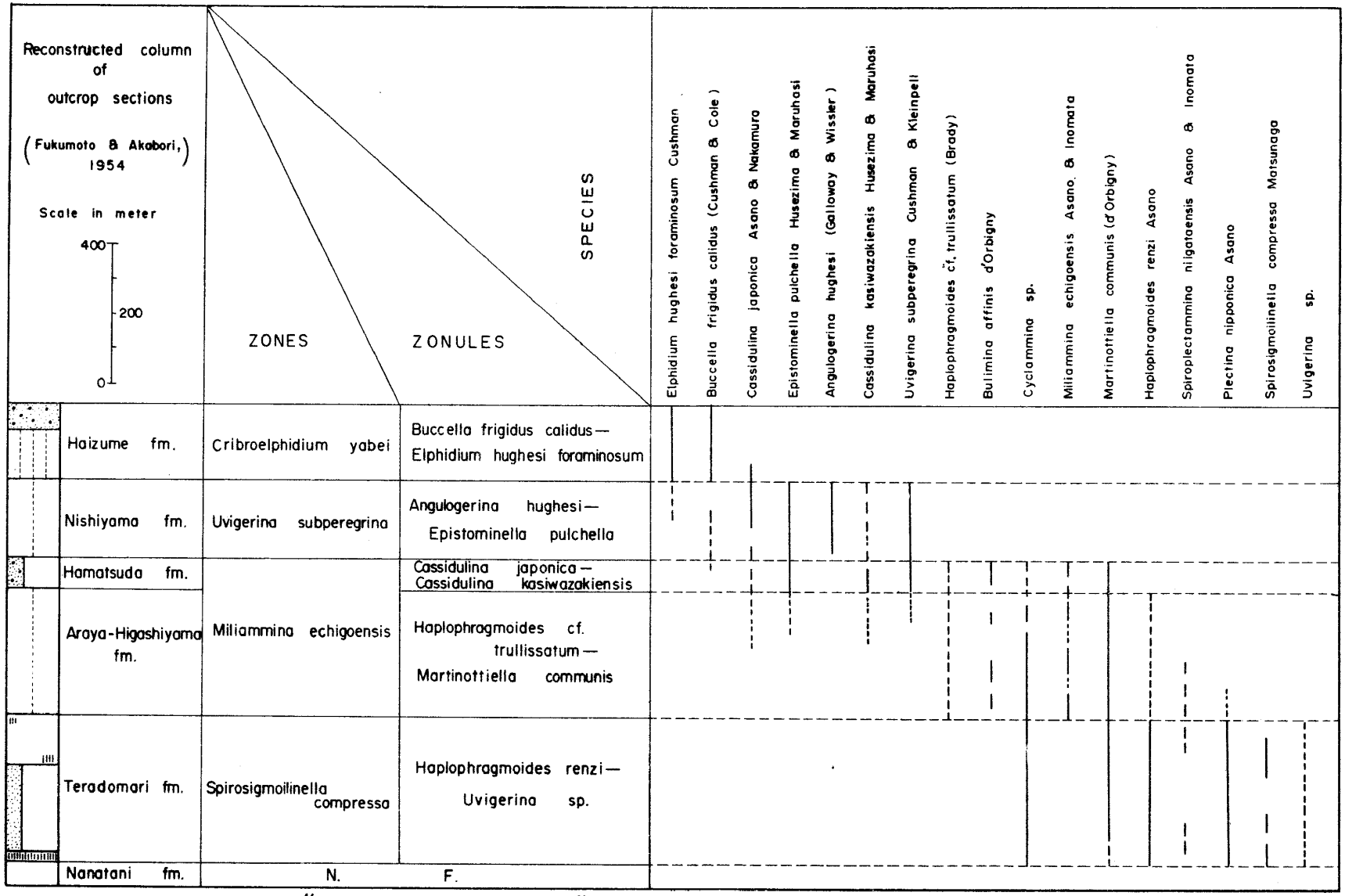
TABLE 17 ( Continued )




Localities : See "Register of localities"

TABLE 18

CHECK LIST SHOWING KNOWN STRATIGRAPHIC OCCURRENCE OF FORAMINIFERA AND ZONULES IN MAKI DISTRICT, NIIGATA PREFECTURE




Localities : See "Register of localities"

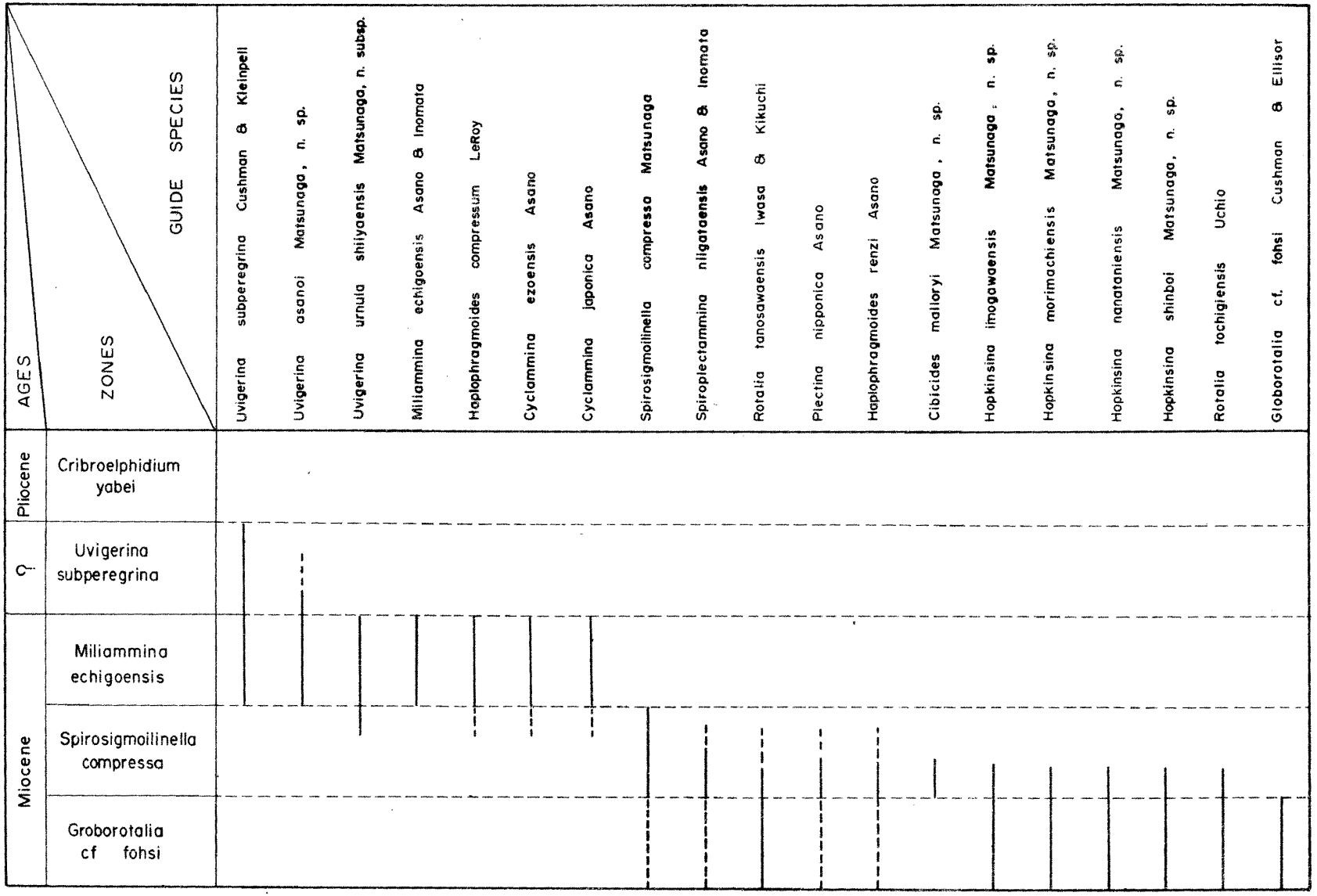
# TABLE 19

## CORRELATION OF THE NEOGENE TERTIARY FORMATIONS IN THE OIL FIELDS OF NORTHERN JAPAN, ON BASIS OF FORAMINIFERAL ZONES.

| AGES | ZONES | N ← SELECTED LOCAL STRATIGRAPHIC SEQUENCES → S | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Akita Pref. | | | Yamagata Pref. | | Niigata Pref. | | | |
| Pliocene | | Katanishi fm. | Terauchi fm. | | | | Jingamine fm. | | | |
| | | Shibikawa fm. | | Shibikawa fm. | Shyonai group | Funagata group | Uonuma group | | | |
| | Cribroelphidium yabei Zone | U. Wakimoto fm. | Tofuiwa m. | | Jojenji fm. | | Haizume fm. | | Wanazu fm. | |
| | | | Sasaoka fm. | | Kannonji fm. | Oriwatari fm. | | | Shiroiwa fm. | |
| ? | Uvigerina subperegrina Zone | L. | U. Tentokuji fm. | | Maruyama fm. | Sakegawa fm. | Nishiyama fm. | | Ushigakubi fm. | |
| | | Kitaura fm. | L. | Katsurane fm. | Tateyama fm. | Ashizawa fm. | Hamatsuda fm. | | | |
| | | | | | | Hanezawa fm. | | | | |
| Miocene | Miliammina echigoensis Zone | Funakawa fm. | U. Nanakura tf. | U. | Tazawa tf. | Furukuchi fm. | Shiiya fm. | | Higashiyama fm. | |
| | | | Funakawa fm. | Manaitayama v. g. | Kitamata fm. | | | | Araya fm. | |
| | Spirosigmoilinella compressa Zone | Onnagawa fm. | L. Nanakura tf. | L. | Kusanagi fm. | | U. Teradomari fm. | | | |
| | | | Onnagawa fm. | | | | L. | | Nanbayama fm. | |
| | Globorotalia cf. fohsi Zone | Nishikurosaw fm. | Uyashinai fm. | | Aosawa fm. | Kanayama group | Nanatani fm. | | Tsugawa fm ? | |
| | | | Sunakobuchi fm. | | | | | | (Kanose fm.) | |
| | | Daijima fm. | Okuramata fm. | | | | Mikawa group | | | |
| | | Monzen fm. | Haginari fm. | | | Nozoki group | | | | |

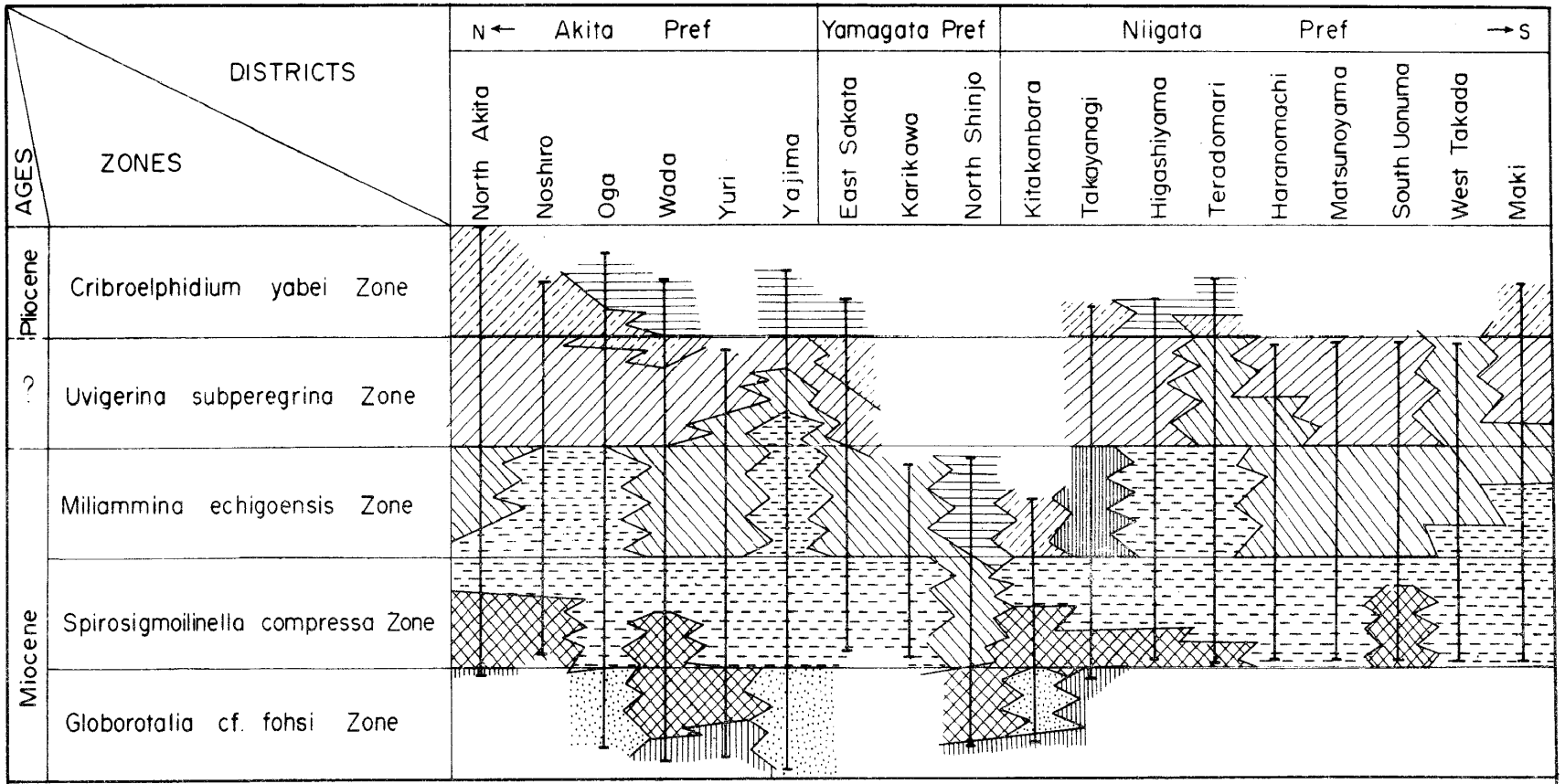
TABLE 20

GEOLOGICAL RANGES OF GUIDE SPECIES IN THE OIL FIELDS OF NORTHERN JAPAN



# TABLE 21

## FORAMINIFERAL FAUNA IN THE OIL FIELDS OF NORTHERN JAPAN



less common. In many cases it is difficult to define the upper limit of this zone.

The important Foraminifera from this zone are:

*Cyclammina ezoensis* Asano
*C. japonica* Asano
*C. pusilla* Brady
*Epistominella pulchella* Husezima and Maruhasi
*Haplophragmoides compressa* LeRoy
*H.* cf. *emaciatum* (Brady)
*H.* cf. *trullisssatum* (Brady)
*Martinottiella communis* (d'Orbigny)
*M. nodulosa* (Cushman)
*Miliammina echigoensis* Asano and Inomata
*Uvigerina asanoi* Matsunaga, n. sp.
*U. subperegrina* Cushman and Kleinpell
*U. urnula shiiyaensis* Matsunaga, n. subsp.

d) *Uvigerina subperegrina* Zone

In this zone Recent species increase, in number and guide species become less common. In many cases the boundaries are marked by a significant faunal change. That is, the upper limit of *Miliammina echigoensis* defines the lower limit of this zone and the part where *Angulogerina, Cassidulina, Epistominella, Uvigerina,* etc. are abundant, is included in this zone. The characteristic Foraminifera from this zone are:

*Angulogerina hughesi* (Galloway and Wissler)
*Cassidulina japonica* Asano and Nakamura
*C. kasiwazakiensis* Husezima and Maruhasi
*C. yabei* Asano and Nakamura
*Epistominella pulchella* Husezima and Maruhasi
*Uvigerina proboscidea* Schwager
*U. subperegrina* Cushman and Kleinpell
*U.* cf. *urnula* d'Orbigny
*U. urnula shiiyaensis* Matsunaga, n. subsp.

e) *Cribroelphidium yabei* Zone

The strata from where *Angulogerina, Epistominella, Uvigerina,* etc. do not appear and *Cibicides, Cribroelphidium, Elphidium, Nonion,* etc. are abundant is included in this zone.

The prominent species from this zone are:

*Cassidulina japonica* Asano and Nakamura
*Cibicides lobatulus* (Walker and Jacob)
*C.* cf. *refulgens* (Montfort)
*Cribroelphidium yabei* (Asano)
*Elphidium fax barbarense* Nicol
*E. hughesi foraminosum* Cushman
*Nonion manpukujiense* Otuka
*Rotalia japonica* Hada
*R.* cf. *papillosa* Brady

The many biostratigraphic zonules indicated in the tables are established by the first appearance of several guide species and by the combination of species. Their relation with the thickness variation of the sediments in one sedimentatary basin and their correlation between other basins are shown in the accompanying figures and tables.

## AKITA AND YAMAGATA PREFECTURES

The general biostratigraphy of the Tertiary formations distributed in Akita and Yamagata Prefectures are shown in Tables 1–9 and 19–21.

The Akasihima and Monzen formations (Fujioka, 1956) which are the lowest units of the Neogene Tertiary in the area comprise basalt, basaltic andesite accompanied with volcanic breccia and volcanic conglomerate. The Atsumi group in Nishitagawa-gun, Yamagata Prefecture belongs to this horizon. It consists chiefly of conglomerate, siltstone, andesite, volcanic conglomerate, breccia tuff, sandstone, etc. In the middle and upper parts *Picea, Pseudotsuga, Abies, Metasequoia, Glyptostrobus, B. sachalinensis, Fagus antipofi, Tilia distans, Ulmus longifolia, Marlea aequalifolia,* etc., which are the elements of the Aniai flora (Tanai, 1955), are reported to occur.

The Daijima formation in the Oga Peninsula (Miyagi, 1958) covers unconformably a part of the Monzen formation, and comprises chiefly green tuff, tuffaceous sandstone,

sandstone, tuffaceous siltstone, etc. From the lower part of the formation in the Monzen area in the Oga Peninsula there have been reported *Metasequoia japonica, Tsuga diversifolia, Picea kannoi, P. ugoana, Carpinus subyessoensis, Betula* sp., etc., all of the Aniai flora (Fujioka, 1950, 1952, 1956, Miyagi, 1958). From the middle and upper parts of the Daijima formation there have been recorded *Glyptostrobus europaeus, Myrica naumanni, Castanea angustifolia, Liquidambar formosana, Marlea aqualifolia,* etc.

The Nishikurosawa formation is superposed on the Daijima with slight unconformity, but conformable at some parts and incorporates the *Globorotalia* cf. *fohsi* zone. This zone yielded *Miogypsina kotoi, Operculina complanata japoniac* and in some places, *Globorotalia* cf. *foshi, G. scitula, Hopkinsina morimachiensis, H. shinoboi,* etc. *Desmostylus japonicus* was also reported from an equivalent horizon in the Yokote District.

The Onnagawa formation which covers the Nishikurosawa with conformity consists chiefly of siliceous mudstone or hard mudstone. It is almost contemporaneous with the Kusanagi formation in Yamagata Prefecture and represents the *Spirosigmoilinella compressa* zone. This zone yielded Buliminidae, Lituolidae, Nodosariidae, Textulariidae, etc. The *Globorotalia* cf. *fohsi* zone and the *Spirosigmoilinella compressa* zone are distinguished by *Globorotalia* cf. *fohsi* and *G. scitula,* or by one of them.

The Funakawa formation conformably superposed upon the Onnagawa in Akita and the so-called Kitamata formation in Yamagata are characterized with black mudstone. Although fossils from the mudstone are scarce, *Conchocele, Lucinoma,* etc. are found. *Miliammina echigoensis* and *Spirosigmoilinella compressa* are found with arenaceous forms as Lituolidae, Textulariidae, etc., and generally the *Spirosigmoilinella compressa* zone and the *Miliammina echigoensis* zone, can be recognized.

The Kitaura formation in the Oga Peninsula, Katsurane formation in the vicinity of Akita City, the lower parts of the Tentokuji formation, and the Tateyama formation in the Shonai district in Yamagata Prefecture consists chiefly of alternating layers of gray siltstone and fine grained sandstone, which yielded *Acila, Yoldia, Conchocele,* etc. These formations are at places conformable or unconformable with the subjacent formations.

The characteristic Foraminifera from the formations are

*Cyclammina ezoensis* Asano
*C. japonica* Asano
*Haplophragmoides* cf. *emaciatum* (Brady)
*H.* cf. *trullissatum* (Brady)
*Martinottiella communis* d'Orbigny
*M. nodulosa* (Cushman)
*Uvigerina subperegrina* Cushman and Kleinpell
*U.* cf. *urnula* d'Orbigny
*U.* cf. *urnula shiiyaensis* Matsunaga, n. subsp.
*U. yabei* Asano

This fauna includes both arenaceous and calcareous forms, and among them the *Uvigerina subperegrina* zone is distinguished.

The rock facies of the Wakimoto formation in the Oga Peninsula is designated as the upper part of the Tentokuji and the Sasaoka formations in the vicinity of Akita City, and the upper part of the Maruyama formation and the Kannonji and Jozenji formations in the Shonai District in Yamagata Prefecture; these comprise medium or fine grained sandstone of grayish white or bluish gray color. This facies yielded the Onma-Manganji fauna, which includes *Anadara ommaensis, Anadara boucardi* etc.

The following Foraminifera are predominant in the *Uvigerina subperegrina* zone in the lower part of this facies.

*Cassidulina kasiwazakiensis* Husezima and Maruhasi
*C. yabei* Asano and Nakamura
*Epistominella pulchella* Husezima and Maruhasi
*Uvigerina asanoi* Matsunaga, n. sp.
*U. excellens* Todd

In the upper part there is the *Cribroelphidium yabei* zone which yielded abundant specimens of *Cassidulina japonica* and *Elphidium hughesi foraminosum.*

Superposed upon the Wakimoto and its equivalent stratigraphic units are the Shibikawa formation in the Oga Peninsula and vicinity of Akita City, and the Shonai group in Yamagata Prefecture. The rocks of these formations generally comprise alternations of soft sandstone and siltstone and in some places lignite is intercalated. The fossils from the mentioned formations resemble the Onma-Manganji fauna and are upper Pliocene in age. From the lower part of the formations there has been distinguished the *Cribroelphidium yabei-Cibicides* cf. *refulgens* zonule which yielded,

*Buccella frigida* (Cushman)
*B. inusitata* Andersen
*Cibicides aknerianus* (d'Orbigny)
*C. lobatulus* (Walker and Jacob)
*C.* cf. *refulgens* (Montfort)
*Cribroelphidium yabei* (Asano)
*Elphidium fax barbarense* Nicol

In the upper part of the above mentioned formations is found the *Rotalia* cf. *papillosa* zonule which yielded, Miliodidae, Nonionidae, Rotaliidae, etc.

The Katanishi formation is superposed upon the Shibikawa with unconformity and may be Pleistocene in age; it has yielded no Foraminifera.

## NIIGATA PREFECTURE

In the Niigata area the lower parts of the Neogene Tertiary are distributed chiefly in the east and south, whereas the middle and upper parts are developed in the Nishiyama and Higashiyama oil-fields. The chronological ranges of the more important Foraminifera in the different areas and correlation of the biostratigraphic units are shown in Fig. 4 and Tables 10–21.

In the north of Tsugawa-machi, Higashikanbara-gun, Niigata Prefecture, the lowest or Mikawa group (Hosoi, 1953, Ikebe and Onizuka, 1949), which comprises porphyritic liparite and porphyrite, is unconformable with the Paleozoic and granitic rocks.

The Mikawa group is covered with unconformity by the Tsugawa formation which consists of conglomerate, sandstone, tuff, etc. In Kitakanbara-gun and Iwafune-gun, the formation contains the *Operculina-Miogypsina* zonule, which yielded *Amphistegina radiata, Miogypsina ozawai, M. kotoi, Operculina complanata, O. complanata japonica*, etc. (Fujimoto, 1934, Matsunaga, 1951).
*Comptoniphyllum naumanni, Liquidambar formosana*, and others, occur from Higashikanbara-gun and the vicinity of Tsugawa. These comprise the Kannonzawa flora (Kryshtofovich, 1920, Chitani, 1935).

The next younger Nanatani formation is conformable with the Tsugawa (Watanabe, 1926, Omura, 1927–1930) and consists chiefly of black mudstone and hard siliceous mudstone. This formation is almost equivalent to the Nanbayama formation in Nishikubiki-gun and the lower part of the Teradomari formation in Santo-gun. This correlation is based upon the micropaleontological data given in Table 19. Fossils are generally rare but the following Foraminifera occurred.

*Cibicides malloryi* Matsunaga, n. sp.
*Haplophragmoides renzi* Asano
*Hopkinsina imogawaensis* Matsunaga, n. sp.
*H. shinboi* Matsunaga, n. sp.
*Plectina nipponica* Asano
*Spiroplectammina niigataensis* Asano and Inomata

From the above mentioned formations the following zonules have been distinguished:–

RF-NF zonule: This zonule has yielded only a few Foraminifera from the hard siliceous mudstone.

*Hopkinsina morimachiensis-Gyroidina orbicularis* zonule: This has yielded many calcareous forms as of the Nodosariidae and others besides *Cibicides* and *Hopkinsina*,

This is accompanied with *Haplophragmoides*, *Plectina*, etc.

In Takayanagi-mura and Imogawa-mura in Minamikanbara-gun, the *Hopkinsina morimachiensis-Gyroidina orbicularis* zonule gradually changes into the NF-RF zonule. There were yielded a few calcareous Foraminifera as *Cibicides*, *Hopkinsina*, etc. and abundant arenaceous ones as *Haplophragmoides*, *Plectina*, *Spiroplectammina*, etc. There are also parts of the stratigraphic units which are represented by the *Haplophragmoides renzi-Plectina nipponica* zonule. This zonule and the *Hopkinsina morimachiensis-Gyroidina orbicularis* zonule interfinger with one another and can be distinguished in the wells in Kakuda-mura, Nishikanbara-gun, and on the ground surface of Teradomari-machi, Santo-gun, and Yahiko-mura, Nishikanbara-gun. The Nanbayama formation (Omura, 1930, Kaneko, 1944, Makiyama, 1950, Morishita, 1950,) in Nishikubiki-gun and the lower parts of the Teradomari formation (Omura, 1928,) distributed in Santo-gun, yielded the same species as those occurring from the Nanatani formation; these are *Haplophragmoides renzi* Asano, *Plectina nipponica* Asano and *Spiroplectammina niigataensis* Asano and Inomata.

From the biostratigraphy, the lower parts of the Teradomari formation and the Nanbayama formation belong to the same horizon, and to the *Globorotaria* cf. *fohsi* zone.

The upper part of the Teradomari formation[1] (Iki, 1905, Omura, 1928, 1930, Ikebe, 1941) consists of black mudstone, an alternation of sandstone and mudstone, sandstone and tuff. In it is distinguished the *Spirosigmoilinella compressa* zone which yielded *Haplophragmoides* cf. *trullissatum* (Brady), *Martinottiella communis* (d'Orbigny) and *Spirosigmoilinella compressa* Matsunaga.

The Shiiya formation is conformably superposed upon the upper part of the Teradomari formation and comprises an alternation of sandstone and mudstone or black mudstone, accompanied with tuffaceous sandstone, tuff, tuff breccia and agglomerate. This formation has yielded, *Cyclammina ezoensis* Asano, *C. japonica* Asano, *Haplophragmoides compressa* LeRoy, *Miliammina echigoensis* Asano and Inomata, *Uvigerina* cf. *urnula* d'Orbigny, *U. urnula shiiyaensis* Matsunaga, n. subsp., *U. asanoi* Matsunaga, n. sp. and the *Miliammina echigoensis* zone.

From the faunal assemblages, the Higashiyama formation (Omura, 1928, Watanabe, 1931) and the Araya formation (Omura, 1928) belong almost to the same horizon.

The Nishiyama formation (Omura, 1927, Ikebe, 1949) which is superposed on the Shiiya with conformity generally consists of gray tuffaceous siltstone and gray or yellowish brown sandstone intercalated with white tuff. Besides *Makiyama chitanii* and *Palliolum peckhami* the following Foraminifera were found, *Cassidulina kasiwazakiensis* Husezima and Maruhasi, *C. yabei* Asano and Nakamura, *Epistominella pulchella* Husezima and Maruhasi, *Uvigerina asanoi* Matsunaga n. sp., and *U. subperegrina* Cushman and Kleinpell. In the formation is distinguished the *Uvigerina subperegrina* zone.

The Nishiyama formation is conformably covered with the Haizume formation (Omura, 1927, Ikebe, 1949) in the Nishiyama oil-field and by the Shiroiwa formation in the Higashiyama oil-field. The Haizume and the Shiroiwa formations consist chiefly of bluish gray siltstone or fine grained sandstone sometimes intercalated with conglomerate, shell-sandstone, etc. According to Kanehara (1950) and others, fossils of molluscs and Foraminifera occur abundantly from the formation. The *Cribroelphidium yabei* zone in the formation yielded;

*Bolivina robusta* H.B. Brady
*Cibicides* cf. *lobatulus* (Walker and Jacob)
*Elphidium fax barbarense* Nicol
*E. hughesi foraminosum* Cushman

1) As already mentioned, the lower part of the Teradomari formation is contemporaneous with the Nanatani formation, but of different facies.

*C.* cf. *refulgens* (Montfort)
*Cribroelphidium yabei* (Asano)
*Discopulvinulina bradyi* (Cushman)
*Nonion manpukujiense* Otuka
*Quinqueloculina lamarkiana* d'Orbigny
*Q. seminula* (Linnaeus)

The Wanazu formation and the Hiu formation cover the Haizume formation with conformity. From the lower parts of the Wanazu formation and the Hiu formation there have been discriminated *Cibicides*, *Elphidium*, *Rotalia*, etc., which show resemblance with the faunule contained in the *Cribroelphidium yabei-Cibicides* cf. *refulgens* zonule. These are accompanied with *Rotalia* cf. *beccarii*, *R. japonica*, *R.* cf. *papillosa*, etc. The horizon characterized with abundant *Rotalia* is called the *Rotalia* cf. *papillosa-Cribroelphidium yabei* zonule. The formations younger than it and the upper parts of the Hiu formation generally do not yield Foraminifera.

## GUIDE SPECIES AND ASSEMBLAGES

The Neogene Tertiary sediments distributed along the coast of the Japan Sea have yielded many benthonic Foraminifera. Among them many species are characteristic, several have short geological range and these are important in zoning of the formations. Species having short geological range in Akita, Yamagata and Niigata Prefectures in stratigraphic positions ranging from Nishikurosawa time (*Globorotalia* cf. *fohsi* zone) up to Tentokuji time (*Uvigerina subperegrina* zone) in the former area and from Tsugawa time (*Globorotaria* cf. *fohsi* zone) up to Nishiyama time (*Uvigerina subperegrina* zone) in the latter area are given in Table 20. These species are, in the order of their appearance, as follows,

*Rotalia tochigiensis* Uchio
*Rotalia tanosawaensis* Iwasa and Kikuchi
*Hopkinsina imogawaensis* Matsunaga, n. sp.
*H. morimachiensis* Matsunaga, n. sp.
*H. nanataniensis* Matsunaga, n. sp.
*H. shinboi* Matsunaga, n. sp.
*Cibicides malloryi* Matsunaga, n. sp.
*Plectina nipponica* Asano
*Haplophragmoides renzi* Asano
*Spiroplectammina niigataensis* Asano and Inomata
*Spirosigmoilinella compressa* Matsunaga
*Cyclammina japonica* Asano
*C. ezoensis* Asano
*Haplophragmoides compressa* LeRoy
*Miliammina echigoensis* Asano and Inomata
*Uvigerina subperegrina* Cushman and Kleinpell
*U. urnula shiiyaensis* Matsunaga, n. subsp.
*U. asanoi* Matsunaga, n. sp.

These guide species are important in zoning of the formations and in correlation of the sediments of the different sedimentary basins.

There can be also observed a remarkable characteristics in the combination of species from the different districts and this may be occured by the change of the sedimentary environment. These combinations of species, from the lower to the upper part of the Neogene sequence, and the distribution of the assemblages in various districts of various zones (Table 21) are as follows:–

1. *Operculina-Miogypsina* Assemblage

This assemblage generally lives in the littoral sand facies.

2. *Hopkinsina-Haplophragmoides* Assemblage

This contains Buliminidae or *Hopkinsina shinboi* etc., and Nodosariidae, Lituolidae, in the lower part, *Globorotalia* cf. *fohsi* coexists but not in the upper part. These live in the mud facies of the outer neritic or bathyal conditions.

3. NF and RF assemblege

Generally no Foraminifera occurs but occasionally poor assemblages are found in the *Globorotalia fohsi* zone and *Spirosigmoilinella compressa* zone.

4. *Haplophragmoides-Spirosigmoilinella* Assemblage

This assemblage is composed of *Haplophragmoides*, *Plectina*, *Spiroplectammina*,

*Spirosigmoilinella*, etc., and planktonic forms are generally rare. The rock facies suggests stagnant conditions.

5. *Haplophragmoides-Uvigerina* Assemblage

This assemblage comprises a mixed fauna of *Cassidulina*, *Cyclammina*, *Epistominella*, *Haplophragmoides*, *Miliammina*, and *Uvigerina* accompanied with planktonic forms. The rock facies and fauna suggest deposition on the continental slope.

6. *Cassidulina-Uvigerina* Assemblage

Besides *Cassidulina*, *Epistominella*, *Uvigerina*, etc., planktonic Foraminifera are abundant. This is a neritic or bathyal deposit.

7. *Cibicides-Cribroelphidium* Assemblage

This assemblage consists of species of the temperate littoral or inner neritic zone. *Cassidulina japonica*, *C. yabei*, *Cibicides* cf. *refulgens*, *Cribroelphidium yabei*, *Elphidium hughesi foraminosum*, *and Quinqueloculina vulgaris* are the characteristic species in the assemblage.

8. *Rotalia-Elphidium* Assemblage

Containing *Cribroelphidium*, *Elphidium*, *Nonion*, *Quinqueloculina*, *Rotalia*, etc., the assemblage is inferred to have lived in the littoral or inner neritic zone.

The change of the foraminiferal faunas, except for particular ones, can be recognized rather uniformly over almost the whole area from Hokkaido in the north to Niigata in the south. When these faunas are compared with the ones from the Kanto District and other Pacific side areas of Japan, a resemblance is found between the two in the lower part of the Miocene, but from upper Miocene to Pliocene, the difference between the faunas is remarkable.

As is shown in Table 20, guide species having short geological range are found in most of the areas extending from the *Globorotalia* cf. *fohsi* zone up to the *Miliammina echigoensis* zone and their equivalents.

Zones younger than the *Miliammina echigoensis* zone yield more Recent species and less extinct ones, therefore, sectioning of the formations must be done according to the changes of the fauna and differences in their assemblages and frequency. This procedure has been found to be fruitful and was employed in the present work.

## DFSCRIPTIONS OF THE NEW SPECIES OR SUBSPECIES OF FORAMINIFERA

From the Neogene Tertiary of the oil fields along the coast of the Japan Sea, 22 families and 114 genera of the benthonic smaller Foraminifera have been discriminated by the writer, including one new genus and 35 new species or subspecies.

In the present work only the new species or new subspecies will be described, but the whole fauna will be illustrated.

### *Spiroplectammina shibataensis* Matsunaga, n. sp.

Pl. 25, fig. 2

Test elongate, slender, compressed, early portion planispiral and later biserial; sutures distinct, slightly depressed, becoming more strongly oblique in later portion; wall finely arenaceous.

Length of holotype 0.70 mm., greatest breadth 0.27 mm.

*Type and occurrence*: – Holotype (IGPS* coll. cat. no. 85040) from the Teikoku Oil Company's Shibata R–16 well, Shibata City, Kitakanbara-gun, Niigata Prefecture, in a core at 643.6 meters depth (Shiiya formation).

*Stratigraphic occurrence*: – Shiiya and Higashiyama formations; common.

* IGPS=Abbreviation for Institute of Geology and Paleontology, Tohoku University, Sendai.

***Lagena asanoi*** Matsunaga, n. sp.
Pl. 31, fig. 5

Test flask-shaped, circular in section; wall calcareous, hyaline, finely perforate, ornamented with numerous thin longitudinal costae extending upward from a tiny ring at base, and merging into a smooth collar; aperture at end of short smooth neck, rounded.

Length of holotype 0.45 mm., width 393 mm. Paratypes range from 0.27 to 0.65 mm. in length.

This species resembles *Lagena apiopleura* Loeblich and Tappan, but differs in the weaker and more numerous costae on the surface of the test.

*Type and occurrence*: – Holotype (IGPS coll. cat. no. 85385) from the Osawa alternation, Osawa, Hashida-mura, Nakakanbara-gun, Niigata Prefecture.

*Stratigrophic occurrence*: – Osawa alternation.

***Oolina oinomikadoi*** Matsunaga, n. sp.
Pl. 32, fig. 1

Test free, globular to ovate in outline, with a short, narrow basal spine; wall calcareous, finely perforate, surface ornamented with weak irregular longitudinal costae; aperture radiate, with internal tube.

Length of holotype 0.55 mm. Other specimens range from 0.40 to 0.65 mm. in length.

Distinguished from *Oolina lineata* (Williamson) by characters of ornamentation.

*Type and occurrence*: – Holotype (IGPS coll. cat. no. 85123) from the Haizume formation, Inagawa, Nishigoshi-mura, Santo-gun, Niigata Prefecture.

*Stratigraphic occurrence*: – Haizume, Nishiyama and Shiiya formations.

***Robulus depressus naigoensis*** Matsunaga, n. subsp.
Pl. 33, figs. 2a, b

This subspecies differs from the species in the very weak keel at the periphery.

Maximum breadth of holotype 98 mm.; thickness 0.20 mm.

*Type and occurrence*: – Holotype (IGPS coll. cat. no. 85386) from the Haizume formation, Haizume, Naigo-mura, Kariwa-gun, Niigata Prefecture.

*Stratigraphic occurrence*: – Haizume formation.

***Astrononion hanyudaense*** Matsunaga, n. sp.
Pl. 35, figs. 8a, b

Test slightly longer than broad, slightly umbilicate, periphery rounded; chambers distinct, about 9 in adult coil, of rather uniform shape, not inflated, supplementary chambers elongate, tubular, small, of rather uniform diameter throughout; sutures distinct, curved, strongly limbate, fusing with ring about umbilicus, not depressed; wall smooth, coarsely perforate; aperture low, arched at base of inner margin of last-formed chamber, those of supplementary chambers semicircular at outer end.

Diameter of holotype 0.42 mm., thickness 0.23 mm. Other specimens range from 0.24 to 0.40 mm. in diameter.

This species differs from *Astrononion umbilicatula* Uchio by the limbate sutures and the umbilicate test. It is also different from *Astrononion italicum* Cushman and Edwards by the umbilicate test, and the ring around the umbilicus.

*Type and occurrence*: – Holotype (IGPS coll. cat. no. 85179) from the Teikoku Oil Company's Hanyuda R–1 well, Hanyuda-mura, Nakakanbara-gun, Niigata Prefecture, in a core at 152.0 meters depth (Shiroiwa formation).
*Stratigraphic occurrence* : – Haizume, Shiroiwa and Sasaoka formations; few.

***Cribroelphidium cribrojenseni*** Matsunaga, n. sp.
Pl. 35, figs. 11a, b

Test much compressed, sides flattened, nearly parallel, umbilical regions flattened, not excavated, with fine granular material, periphery acute, slightly keeled; chambers distinct, 15 to 18 in final coil, narrow, curved; sutures distinct, curved, somewhat elevated; retral processes distinct, extending nearly across chamber; wall almost completely covered by raised sutures and retral processes; aperture in adult form consists of a group of rounded pores on apertural face.

Greatest diameter of holotype 0.68 mm., thickness 0.20 mm. Other specimens range from 0.38 to 0.55 mm. in diameter.

This species resembles *Elphidium jenseni*, but differs by the character of apertures.
*Type and occurrence*: – Holotype (IGPS coll. cat. no. 85182) from Teikoku Oil Company's Yahiko R–1 well, Yahiko-mura, Nishikanbara-gun, Niigata Prefecture, in a core at 509.0 meters depth (Shiiya formation).
*Stratigraphic occurrence*: – Shiiya, Haizume, Shiroiwa, Kannonji and Sasaoka formations; few.

***Cribroelphidium kannonjiense*** Matsunaga, n. sp.
Pl. 35, figs. 12a, b

Test somewhat compressed, distinctly umbonate, rhomboid in peripheral veiw, periphery rounded, chambers fairly distinct, slightly inflated in later ones, 10 to 16 in last-formed coil, of rather uniform size and shape; sutures distinct, depressed, curved, retral processes short, often indistinct; wall thick and smooth; aperture in adult form consists of a group of rounded pores on apertural face.

Diameter of holotype 0.88 mm., thickness 0.46 mm. Other specimens range from 0.80 to 1.35 mm. in diameter.

This species differs from *Cribroelphidium ezoense* (Asano) by the slightly umbonate swollen test.
*Type and occurrence*: – Holotype (IGPS coll. cat. no. 85184) from the Kannonji formation in Kannonji-mura, Akumi-gun, Yamagata Prefecture.
*Stratigraphic occurrence*: – Kannonji formation; rare.

***Cribroelphidium nishiyamaense*** Matsunaga, n. sp.
Pl. 35, figs. 13a, b

Test of medium size, margin entire, periphery in earlier portion slightly angled, in later portion rounded, slightly lobulate; umbilical region slightly raised with clear circular beads; chambers distinct, not inflated, 7 to 10 in adult coil; sutures not depressed, marked by slightly raised, rectangular or circular retral processes; wall smooth, finely perforate; aperature in adult form consists of a group of rounded pores on apertural face.

Diameter of holotype 0.85 mm., thickness 0.38 mm. Other hypotypes range from 0.58 mm. to 0.85 mm. in diameter.

This species resembles *Elphidium papillosum* Cushman, but differs by the surface ornamentation of wall and character of apertures.
*Type and occurrence*: – Holotype (IGPS coll. cat. no. 85185) from the Haizume formation in Nishiyama-mura, Kariwa-gun, Niigata Prefecture.

*Stratigraphic occurrence*: – Haizume formation; rare.

***Elphidium asanoi*** Matsunaga, n. sp.
Pl. 36, figs. 6a, b

Test rather small, periphery broadly rounded throughout, especially in later chambers, diameter about two and one-half times thickness; umbilical region slightly depressed; chambers distinct, slightly inflated, 8 to 10 in adult coil, of uniform shape, increasing very slightly in size as added; sutures slightly limbate, slightly curving toward periphery, retral processes few and short; wall finely perforate, early portion with slender spines; aperture a series of small rounded openings at base of apertural face.

Diameter of holotype 0.38 mm., thickness 0.22 mm. Other specimens range from 0.36 to 0.46 mm. in diameter.

This new species can be distinguished from *Elphidium hokkaidoense* Asano, by the fewer chambers and different surface ornamentation of the early portion.

*Type and occurrence*: – Holotype (IGPS coll. cat. no. 85190) from the Tsugawa formation, Sakai, Kurokawa-mura, Kitakanbara-gun, Niigata Prefecture.

*Stratigraphic occurrence*: – Tsugawa formation; rare.

***Nonion aimonoi*** Matsunaga, n. sp.
Pl. 37, figs. 2a, b

Test much compressed, bilaterally symmetrical, involute, umbilicus slightly depressed, periphery rounded; chambers distinct, 10 to 12 in adult coil, not inflated; sutures distinct, limbate, slightly curved; wall smooth, coarsely perforate; aperture an elongate, narrow slit, at the base of the apertural face.

Diameter of holotype of 0.47 mm., thickness 0.22 mm. Other specimens range from 0.35 to 0.58 mm. in diameter.

This new species differs from *Nonion pacificum* (Cushman) by the limbate sutures and larger numbers of chambers, and from *Nonion nicobarense* Cushman by the round peripheral margins and a larger number of chambers and weak limbate sutures.

*Type and occurrence*: – Holotype (IGPS coll. cat. no. 85387) from the Haizume formation of Oshima-mura, Higashikubiki-gun, Niigata Prefecture.

*Stratigraphic occurrence*: – Haizume, Shiroiwa and Sasaoka formations; few.

***Nonion nagasawaense*** Matsunaga, n. sp.
Pl. 37, figs. 7a, b

Test depressed, bilaterally symmetrical, umbilical region slightly depressed, filled with a granular mass of secondary shell material, periphery subacute; chambers distinct, 13 to 15 in adult coil; wall smooth, finely perforate; sutures distinct, strongly limbate, raised, strongly curved; aperture a narrow slit at base of apertural face.

Diameter of holotype 0.70 mm., thickness 0.37 mm. Other specimens range from 0.60 to 0.78 mm. in diameter.

Differs from *Nonion nakosoense* Asano in having strongly limbate and raised sutures.

*Type and occurrence*: – Holotype (IGPS coll. cat. no. 85201) from the Kusanagi formation in Nagasawa-mura, Mogami-gun, Yamagata Prefecture.

*Stratigraphic occurrence*: – Kusanagi formation; few.

***Nonionella higashiyamaensis*** Matsunaga, n. sp.
Pl. 38, figs. 3a, b, c

Test about one and a half times as long as broad, periphery evolute, ventral side involute; chambers about 6 in adult coil, indistinct, increasing rapidly in size and length as added, slightly inflated, except on ventral side, where last-formed one has an enlarged lobe over umbilical area; sutures indistinct, not depressed slightly curved; wall smooth; aperture low, elongate.

Diameter of holotype 0.38 mm., thickness 0.25 mm. Other specimens range from 0.33 mm. to 0.40 mm. in diameter.

This species resembles *Nonionella extensa* Brotzen from the Cretaceous of Sweden but differs in the less number of chambers.

*Type and occurrence*: – Holotype (IGPS coll. cat. no. 85206) from the Higashiyama formation, Nobe River, Koshi-gun, Niigata Prefecture.

*Stratigraphic occurrence*: – Higashiyama and Shiiya formations; rare.

***Nonionella*** sp.
Pl. 38, figs. 4a, b, c

Test slightly longer than broad, periphery rounded, last formed chamber covering umbilical area on one side, opposite side showing earlier coils; chambers distinct, slightly inflated, about 6 in adult coil; sutures distinct, slightly depressed, gently curved; wall smooth, coarsely perforate with a clear area above aperture; aperture extending over into ventral side.

Diameter of hypotype 0.43 mm., thickness 0.28 mm.

*Type and occurrence*: – Hyptotype (IGPS coll. cat. no. 85208) from the Teikoku Oil Company's Kakuda R–1 well, Kakuda-mura, Nishikanbara-gun, Niigata Prefecture, in a core at 111.5 meters depth (Nishiyama formation).

*Stratigraphic occurrence*: – Nishiyama formation; very rare.

***Pseudononion kanbaraense*** Matsunaga, n. sp.
Pl. 38, figs. 8a, b, c

Test circular, slightly longer than broad, asymmetrical, compressed; umbilicus depressed, often covered with a few very small granular shell material; dorsal side somewhat evolute, ventral side completely involute; periphery subacute; chambers distinct, numerous, about 13 in final coil; sutures distinct, limbate, slightly curved; wall smooth, finely perforate; aperture small, at base of apertural face.

Diameter of holotype 0.33 mm., thickness 0.08 mm. Other specimens range from 0.33 mm. to 0.50 mm. in diameter.

Differs from *Pseudononion tredecum* Asano in few numbers of chambers and strongly limbate sutures.

*Type and occurrence*;–Holotype (IGPS coll. cat. no. 85211) from the Daido Oil Company's Matsunaga R–1 well, Matsunaga-mura, Nishikanbara-gun, Niigata Prefecture, in a core at 451.0 meters depth (Haizume formation).

*Stratigraphic occurrence*: – Haizume and Shiroiwa formations; common. Also Sasaoka and Kannonji formations.

***Pseudononion oinomikadoi*** Matsunaga, n. sp.
Pl. 39 figs, 1a, b, c

Test longeer than broad, asymmetrical, much compressed; dorsal side partially

involute, ventral side completely involute; umbilical regions of ventral side filled with secondary shell material; periphery subacute; chambers distinct, and inflated, 11 to 13 in last-formed coil; sutures distinct, not depressed, limbate; wall smooth, finely perforate; narrow aperture at base of apertural face.

Diameter of holotype 0.30 mm., thickness 0.09 mm. Other specimens range from 0.28 mm to 0.43 mm. in diameter.

*Type and occurrence*: – Holotype (IGPS coll. cat. no. 85212) from the Teikoku Oil Company's Suibara R–3 well, Sasaka-mura, Kitakanbara-gun, Niigata Prefecture, in a core at 260.0 meters depth (Ushigakubi formation).

*Stratigraphic occurrence*: – Haizume, Ushigakubi, Shiroiwa and Sasaoka formations.

***Bulimina kamedaensis*** Matsunaga, n. sp.
Pl. 40, figs. 2a, b

Test elongate, two and a half times as long as broad, tapering, subacute at initial end; chambers numerous, distinct; sutures slightly depressed, distinct; wall smooth, very finely perforate; aperture loop shaped, with a lip.

Length of holotype 0.99 mm., diameter 0.51 mm. Other specimens range from 0.77 to 0.99 mm. in length, diameter 0.40 to 0.62 mm.

The specimens are similar to *Bulimina elongata tenera* Reuss, but have different shape of test.

*Type and occurrence*: – Holotype (IGPS coll. cat. no. 85225) from the Teikoku Oil Company's Kameda R–1 well, Kameda-machi, Yuri-gun, Akita Prefecture, in a core at 215 meters depth (Onnagawa formation).

*Stratigraphic occurrence*: – Onnagawa formation; rare.

***Bolivina striatula nishikanbaraensis*** Matsunaga, n. subsp.
Pl. 40, figs. 14a, b

This subspecies differs from the species in the greaters number of costae, and strongly oblique sutures.

Length 0.38 mm., greatest diameter 0.16 mm., thickness 0.05 mm.

*Type and occurrence*: – Holotype (IGPS coll. cat. no. 85236) from the Teikoku Oil Company's Sone R–1 well, Sone-mura, Nishikanbara-gun, Niigata Prefecture, in a core at 339.5 meters depth (Uonuma group).

*Stratigraphic occurrence*: – Wanazu formation and Uonuma group; rare.

***Suggrunda yahikoensis*** Matsunaga, n. sp.
Pl. 41, figs. 10a, b; 11a, b

Test small, biserial, about one and one-half times as long as broad, much compressed, greatest breadth at apertural end; chambers numerous, distinct; sutures distinct, depressed, strongly oblique, nearly straight; wall ornamentated by a raised ridge; aperture situated at base of apertural face, semi-lunate.

Length 0.28 mm., breadth 0.31 mm., thickness 0.14 mm.

*Type and occurrence*: – Holotype (figs. 11a, b, IGPS coll. cat. no. 85243) from the Teikoku Oil Company's Yahiko R–1 well, Yahiko–mura Nishikanbara-gun, Niigata Prefecture, in a core at 437 meters depth (Shiiya formation).

*Stratigraphic occurrence*: – Haizume and Nishiyama formations; rare

***Angulogerina kawabeensis*** Matsunaga, n. sp.
Pl. 42, figs. 1a, b

Test about twice as long as broad, greatest breadth usually below middle, generally triangular in transverse sections, broadly rounded; chambers distinct, inflated; sutures distinct, depressed; wall smooth but rough; aperture terminal ,elongate, oval, with a short neck.

Length 0.42 mm., greatest diameter 0.21 mm.

The specimens resemble *Angulogerina kokozuraensis* Asano, but differ by the coarse materials of wall.

*Type and occurrence*: – Holotype (IGPS coll. cat. no. 85251) from the Wakimoto formation, in Iwamisannai-mura, Kawabe-gun, Akita Prefecture.

*Stratigraphic occurrence*: – Nishiyama, Ushigakubi, Tentokuji and Wakimoto formations; few.

***Hopkinsina imogawaensis*** Matsunaga, n. sp.
Pl. 42, figs., 3a, b

Test large, about twice as long as broad, greatest thickness about middle; chambers distinct, inflated, later portion tending to become biserial; sutures distinct, depressed; wall covered with bluntly rounded, spinose projections; aperture rounded or irregularly compressed, with a short, distinct neck.

Length 0.91 mm., greatest diameter 0.43 mm.

This species resembles *Hopkinsina notohispida* Finlay, but differs by the ornamentation of wall.

*Type and occurrence*: – Holotype (IGPS coll. cat. no. 85253) from the Nanatani formation at Kitaimogawa, Morimachi-mura, Minamikanbara-gun, Niigata Prefecture.

*Stratigraphic occurrence*: – Nanatani, Kusanagi and Onnagawa formations; few.

***Hopkinsina morimachiensis*** Matsunaga, n. sp.
Pl. 42, figs. 4a, b

Test large, slightly longer than broad, somewhat compressed and tending to become biserial, greatest breadth at about middle; chambers fairly distinct; sutures distinct, depressed; wall roughened with slight spinose projections; aperture rounded with a short but distinct neck.

Length 0.55 mm., greatest diameter 0.38 mm.

This species resembles *Hopkinsina imogawaensis* Matsunaga, n. sp., but differs by the different ratio of length and breadth of the test and by the rough surface of wall.

*Type and occurrence*: – Holotype (IGPS coll. cat. no. 85254) from the Nanatani formation at Kitaimogawa, Morimachi-mura, Minamikanbara-gun, Niigata Prefecture.

*Stratigraphic occurrence*: – Nanatani, Kusanagi and Onnagawa formations; rare.

***Hopkinsina morimachiensis umedaensis*** Matsunaga, n. subsp.
Pl. 42, figs. 5a, b

This new subspecies differs from the species in having a slender test and the surface ornamentation without spinose projections.

Length 0.83 mm., greatest diameter 0.42 mm.

*Type and occurrence*: – Holotype (IGPS coll. cat. no. 85255) from the Teikoku Oil Company's Umeda R–2 well, Umeda, Nishigoshi-mura, Santo-gun, Niigata Prefecture, in a core at 1363 meters depth (Shiiya formation).

*Stratigraphic occurrence*: – Nanatani and Shiiya formations; scarce.

***Hopkinsina nanataniensis*** Matsunaga, n. sp.
Pl. 42, figs. 6a, b

Test large, stout broadly fusiform, greatest width at middle, periphery slightly lobulated; chambers few, inflated; sutures somewhat depressed, earlier ones obscured by ornamentation; wall ornamented with longitudinal costae continuous across sutures but surface of last chamber smooth; aperture with a short neck and lip.

Length 0.79 mm., greatest diameter 0.39 mm.

This species differs from *Uvigerina gesteri* Barbat and von Estorff by the short biserial stage of test and smooth surface of last chamber.

*Type and occurrence*: – Holotype (IGPS coll. cat. no. 85256) from the Teikoku Oil Company's Kitakaji R–2 well, Kaji-mura, Kitakanbara-gun, Niigata Prefecture, in a core at 607 meters depth (Nanatani formation).

*Stratigraphic occurrence*: – Nanatani, Kusanagi and Onnagawa formations; few.

***Hopkinsina shinboi*** Matsunaga, n. sp.
Pl. 42, figs. 7a, b

Test elongate, slender, fusiform, tending to become biserial in later portion; chambers numerous, distinct, inflated; sutures distinct, deeply incised; wall ornamented with very fine spine; aperture terminal, with a short neck, and phialine lip.

Length 0.48 mm., greatest diameter 0.16 mm.

This species differs from *Hopkinsina morimachiensis* Matsunaga, n. sp. and *Hopkinsina imogawaensis* Matsunaga, n. sp. by the small and elongate test with finely spinose surface ornamentation.

*Type and occurrence*: – Holotype (IGPS coll. cat. no. 85257) from the Teikoku Oil Company's Kitakaji R–2 well, Kaji-mura, Kitakanbara-gun, Niigata Prefecture, in a core at 607 meters depth (Nanatani formation).

*Stratigraphic occurrence*: – Nanatani, Kusanagi and Onnagawa formations; common.

***Uvigerina asanoi*** Matsunaga, n. sp.
Pl. 42, figs. 10a, b

Test large, elongate, about twice as long as broad, greatest breadth about middle of test, periphery lobulated; chambers distinct, inflated; sutures deeply incised, curved; wall ornamented by numerous, low, regular, longitudinal costae, not continuous across sutures, becoming strongly serrate or spinous on last-formed chamber; aperture at end of a short neck with a phialine lip.

Length 0.82 mm., greatest diameter 0.31 mm.

This species resembles *Uvigerina peregrina dirupta* Todd, but differs by the sharp longitudinal costae in the earlier chambers and the serrated costae of the last chamber and also from *Uvigerina akitaensis* Asano by the distinct serate or spinous costae of the last chamber.

*Type and occurrence*: – Holotype (IGPS coll. cat. no. 85260) from the Nishiyama formation, Yoita-machi, Santo-gun, Niigata Prefecture.

*Stratigraphic occurrence*: – Nishiyama, Ushigakubi, Tentokuji, Shiiya, Higashiyama and Katsurane formations; common.

***Uvigerina urnula shiiyaensis*** Matsunaga, n. subsp.
Pl. 43, figs. 4a, b

This subspecies is distinguishable from the species by the different wall ornamentation of which costae are weak in the early portion of the test but become rough in the adult.

Length 0.68 mm., greatest diameter 0.29 mm.

*Type and occurrence*: – Holotype (IGPS coll. cat. no. 85266) from the Teikoku Oil Company's Umeda R–1 well, Umeda, Nishigoshi-mura, Santo-gun, Niigata Prefecture, in a core at 1408 meters depth (Shiiya formation).

*Stratigraphic occurrence*: – Shiiya and Katsurane formations.

***Heronallenia oinomikadoi*** Matsunaga, n. sp.
Pl. 44, figs. 6a, b

Test oval, planoconvex, dorsal side convex, ventral side almost flat, 6 to 7 chambers in last formed whorl; periphery lobulate, subacute; sutures on dorsal side not limbate, depressed and slightly oblique dorsally; near peripheral margin, blunt spinose projections of wall are characteristic; aperture ventral, a small rounded opening on inner margin of final chamber.

Greatest diameter of holotype 0.36 mm., thickness 0.21 mm.

*Type and occurrence*: – Holotype (IGPS coll. cat. no. 85278) from the Wakimoto formation, Funakawa-machi, Minamiakita-gun, Akita Prefecture.

*Stratigraphic occurrence*: – Wakimoto and Ushigakubi formations.

***Höglundina asanoi*** Matsunaga, n. sp.
Pl. 23, figs. 7a, b, c

Test small, compressed, biconvex, usually more convex on ventral side, composed of 3 or 4 whorls, periphery angled with a narrow thin carina; chambers distinct, 6 to 7 in adult whorl; sutures limbate; wall finely perforate, showing complex pattern of ornamentation; supplem- entary aperture of long slits, parallel to periphery, main aperture a narrow slit at base of last chamber,

Greatest diameter of holotype 0.61 mm. thickness 0.31 mm. Diameter of other specimens range from 0.72 to 0.40 mm.

This species resembles *Höglundina elegans* (d'Orbigny), but differs in the distinct carina of the periphery.

*Type and occurrence*: – Holotype (IGPS coll. cat. no. 77 260) from the Haizume formation, Inagawa, Nishigoshi-mura, Santo-gun, Niigata Prefecture.

*Stratigraphic occurrence*: – Tofuiwa and Haizume formations.

***Cassidulinoides sasaokaensis*** Matsunaga, n. sp.
Pl. 49, figs. 5a, b

Test longer than broad, compressed, close-coiled for most part of test, but last two or three chambers tending to uncoil, periphery slightly angled; chambers distinct, few; sutures distinct, not depressed; wall smooth; aperture narrow, elongate in adult.

Greatest length of holotype 0.33 mm., breadth 0.19 mm., thickness 0.07 mm. Other specimens range from 0.29 to 0.40 mm. in length, 0.15 to 0.20 mm. in breadth.

This new species resembles *Cassidulinoides bradyi* (Norman), but differs in the less elongate and more compressed test.

*Type and occurrence*: – Holotype (IGPS oll. cat. no. 85357) from the Ushigakubi forma-

tion, Sasaoka-mura, Kitakanbara-gun, Niigata Prefecture.
*Stratigraphic occurrence*: – Ushigakubi formation.

Genus ***Echigoina*** Matsunaga, n. gen.
Type-species: – ***Echigoina hataii*** Matsunaga, n. sp.

Test trochoid in young, often involute in adult; periphery rounded to acute; chambers numerous; wall calcareous, perforate; aperture at base of apertural face, extending on to both ventral and dorsal sides along inner margin of chamber, with a slight lip, umbilical area covered with thin plates extending from each chamber to center of test.

This new genus resembles *Anomalinoides* Brotzen (1942) or *Hyalinea* Hofker (1951), but it is distinguishable from both of them, by the different characters of the aperture and umbilical plates on both sides of each adult chamber.
*Geologic range*: — Miocene to Pliocene, Japan.

***Echigoina hataii*** Matsunaga, n. sp.
Pl. 50, figs. 4a, b

Test biconvex, periphery rounded, not lobulate, dorsal side showing all whorls, ventral side involute and usually umbilicate; chambers 8 to 10 in adult coil, of uniform shape, increasing slowly in size as added, slightly inflated; sutures somewhat depressed, limbate in early stage; wall smooth, coarsely perforate; aperture low, at base of apertural face, with distinct lip, and extending on to both sides along inner margin of chamber, with umbilical thin plates in each adult chamber.

Greatest diameter of holotype 0.65 mm., thickness 0.23 mm. Other specimens range from 0.32 mm. to 0.67 mm. in diameter.
*Type and occurrence*: – Holotype (IGPS oll. cat. no. 85368) from the Koguchi formation, Hashida, Niitsu City, Niigata Prefecture.
*Stratigraphic occurrence*: – Nishiyama, Ushigakubi, Koguchi, Tentokuji and Wakimoto formations; rare.

***Echigoina furutsuensis*** Matsunaga, n. sp.
Pl. 50, figs. 3a, b

Test small, much compressed, evolute, nearly bilaterally symmetrical, periphery subacute to rounded; chambers distinct, 8 to 9 in last whorl, gradually increasing in size as added but uniform in shape; sutures strongly limbate on both sides, slightly curved, raised; wall smooth, finely perforate; aperture a slit at base of apertural face, running down to umbilical side along spiral suture, with a narrow, thin lips in each adult chamber.

Greatest diameter of holotype 0.26 mm., thickness 0.12 mm. Other specimens range from 0.12 mm. to 0.29 mm. in diameter.

This species resembles *Hyalinea baltica* (Schroter), but differs by the narrow, umbilical plate of each chamber.
*Type and occurrence*: – Holotype (IGPS coll. cat. no. 85369) from the Teiokoku Oil Company's Furutsu R–1 well, Furutsu-mura, Kitakanbara-gun, Niigata Prefecture, in a core at 682.8 meters depth (Ushigakubi formation).
*Stratigraphic occurrence*: – Ushigakubi and Shiiya formations; few.

***Planulina granotruncana*** Matsunaga, n. sp.
Pl. 50, figs. 6a, b, c

Test small, much compressed, dorsal side evolute, slightly convex, composed of about

7 chambers in last whorl, ventral side flat; periphery truncate, double-keeled; sutures greatly curved, strongly limbate and raised; wall coarsely perforate, ventral surface covered with granular shell material at umbilical area; aperture low at base of last chamber.

Greatest diameter of holotype, 0.36 mm., thickness 0.05 mm. Other specimens range from 0.29 to 0.38 mm. in diameter.

This new species resembles *Planulina crassa* Galloway and Heminway, but differs by the ornamentation of the umbilical area on the ventral side of test.

*Type and occurrence*: – Holotype (IGPS coll. cat. no. 85370) from the Nishiyama formation, Yoita-machi, Santo-gun, Niigata Prefecture.

*Stratigraphic occurrence*: – Nishiyama and Ushigakubi formations; scarce.

***Cibicides asanoi*** Matsunaga, n. sp.
Pl. 51, figs. 4a, b, c

Test medium size, unequally biconvex, dorsal side showing all whorls and much less convex than ventral, periphery acute, keeled; chambers distinct, 7 to 9 in last whorl; sutures distinct, gently curved, slightly limbate; wall perforate; aperture peripheral, low arch at base of last chamber.

Greatest diameter of holotype 0.45 mm. thickness 0.20 mm. Other specimens range from 0.34 to 0.51 mm. in diameter.

The specimens differ from *Cibicides pseudoungerianus* (Cushman) by the gently curved and slightly limbate sutures.

*Type and occurrence*: – Holotype (IGPS coll. cat. no. 85376) from the Teiokoku Oil Company's Sakamachi R–2 well, Honai-mura, Iwafune-gun, Niigata Prefecture, in a core at 132.0 meters depth (Ushigakubi formation).

*Stratigraphic occurrence*: – Nishiyama, Ushigakubi and Wakimoto formations; few.

***Cibicides inagawaensis*** Matsunaga, n. sp.
Pl. 51, figs. 5a, b, c

Test trochoid, dorsal side flat to slightly convex, ventral side strongly convex; periphery acute, with a slight keel; chambers 6 to 8 in last coil; sutures curved, slightly limbate, distinct; wall smooth, coarsely perforate; aperture a low arched opening at base of last chamber.

Diameter of holotype 0.52 mm., 0.19 mm. in thickness.

The specimens resemble *Cibicides tapoengensis* LeRoy from the Miocene of Central Sumatra, but differ by the fewer chambers and by more oblique and slightly limbate sutures on the dorsal side.

*Type and occurrence*: – Holotype (IGPS coll. cat. no. 85377) from the Haizume formation, Inagawa, Nishigoshi-mura, Santo-gun, Niigata Prefecture.

*Stratigraphic occurrence* : – Haizume and Shiroiwa formations.

***Cibicides malloryi*** Matsunaga, n. sp.
Pl. 51, figs. 7a, b, c; 8a, b, c

*Cibicides pseudowuellorstorffi* (?) Mallory, 1959, Low. Tert. Bistor. Cal. Coast. Ranges, p. 270, pl. 26, figs. 4a-c.

Test trochoid, biconvex, dorsal side showing all whorls and more convex than ventral, periphery sharply angled, with a narrow keel; chambers 9–11 in adult coil; sutures curved, limbate, sometimes indistinct; wall coarsely perforate on dorsal side, less coarsely perforate ventrally; aperture a low arched opening at base of last chamber.

Greatest diameter of holotype 0.44 mm. thickness 0.20 mm. Other specimens range

from 0.30 to 0.51 mm. in diameter.

This species differs from *Cibicides yabei* Asano, by the biconvex test and distinctly keeled periphery.

*Type and occurrence*: – Holotype (IGPS coll. cat. no. 77259) from the Teikoku Oil Company's Sakamachi R–1 well, Honai-mura, Iwafune-gun, Niigata Prefecture, in a core at 425.0 meters depth (Nanatani formation).

*Stratigraphic occurrence*: – Nanatani, Teradomari, Kusanagi and Onnagawa formations; common.

***Cibicides yoitaensis*** Matsunaga, n. sp.
Pl. 52, figs. 3a, b, c

Test large, unequally biconvex, dorsal side much less convex than ventral, earlier whorls more or less obscured by secondary development of translucent shell material; periphery acute, with slight keel; chambers distinct, 8 to 10 in adult whorl. Chambers on dorsal side rather indistinct except later whorls; sutures curved, limbate, distinct; wall smooth, coarsely perforate; aperture a low arched opening at base of last chamber.

Greatest diameter of holotype 0.52 mm., thickness 0.22 mm. Other specimens range from 0.46 mm. to 0.59 mm. in diameter.

This species resembles *Cibicides mexicana* Nuttall but differs by the fewer chambers.

*Type and occurrence*: – Holotype (IGPS coll. cat. no. 85381) from the Teikoku Oil Company's Yoita R–2 well, Yoita-machi, Santo-gun, Niigata Prefecture, in a core at 920 meters depth (Nanatani formation).

*Stratigraphic occurrence*: – Nanatani and Wanazu formations; rare.

## LOCALITIES

The localities of the surface samples in Tables 1, 3, 4, 5, 6, 8, 9, 11, 12, 13, 14, 15, 17, 18, are as follows:

NORTH AKITA DISTRICT, AKITA PREFECTURE, TABLE 1

Localities: Collected by H. Matsuoka, 1955.
Mizusawa River, Iwako, Sawane-mura, Yamamoto-gun,
Hanawa River, Hanawa-Nagaki, Hanawagawa-mura, Yamamoto-gun,
Taneume River, Ohata, Taneume-mura, Yamamoto-gun,
Koani River, Ouchizawa, Konani-mura, Kitaakita-gun,
Oase-Odase, Kamikoani-mura, Kitaakita-gun,
Takinosawa, Yonaizawa-mura, Kitaakita-gun.

OGA DISTRICT, AKITA PREFECTURE, TABLE 3

Localities: Collected by T. Oinomikado, 1945, T. Oinomikado and H. Iwamoto, 1951, H. Matsuoka, 1957.
Kitaura-machi, Oga City,
Mitsumorishinden, Oganaka, Oga City,
Funakawaminato, Wakimoto-machi, Oga City.

WAKA DISTRICT, AKITA PREFECTURE, TABLE 4

Localities: Collected by H. Matsuoka, 1957, 1958.
Sannai River, Iwamisannai-mura, Kawabe-gun,
Arakawa River, Arakawa-mura, Senpoku-gun,
Imaizumi River, Oinai-Nishiimaizumi, Tsuchikawa-mura, Senpoku-gun,
Gongenyama, Minaminaraoka-mura, Senpoku-gun,
Omagarinishine-Ioka, Omagari-City,
Ishimochi-Happotoge, Omagari-City,
Koidesawa-Nakayama-Hachimoriyama, Omagari-City,

Imo River, Kamikawaouchi-mura, Yuri-gun,
Shimoouchimura, Sotokotomo-mura, Yuri-gun.

YURI DISTRICT, AKITA PREF ECTURE, TABLE 5

Localities: Collected by H. Kurosaka, 1957.
Michikawa, Michikawa-mura, Yuri-gun,
Kameda-mura, Honjo City,
Akada River, Akada, Honjo City.

YAJIMA DISTRICT, AKITA PREFECTURE, TABLE 6

Localities: Collected by H. Inoue and others, 1958.
Bugyomen-Yoshizawa, Yuri-mura, Yuri-gun,
Yajima-machi, Yuri-gun.

KARIKAWA DISTRICT, YAMAGATA PREFECTURE, TABLE 8

Localities: Collected by K. Takahashi, 1957.
Mikuriya, Hirata-mura, Akumi-gun,
Onumashinden, Mastuyama-machi, Akumi-gun,
Yamazaki-Kiyokawa, Tachikawa-machi, Higashitagawa-gun,
Kimoiri, Tachikawa-machi, Higashitagawa-gun,
Soegawa, Fujishima-machi, Higashitagawa-gun,
Haguroyama, Haguro-machi, Higashitagawa-gun.

NORTH SHINJO DISTRICT, YAMAGATA PREFECTURE, TABLE 9

Localities: Collected by H. Inoue, 1951, H. Inoue and others, 1958.
Kamabuchi, Nozoki-mura, Mogami-gun,
Komata River, Osawa, Araki-mura, Mogami-gun,
Osawa River, Osawa, Araki-mura, Mogami-gun.

TAKAYANAGI DISTRICT, NIIGATA PREFECTURE TABLE 11

Localities: Collected by T. Matsunaga, 1950.
Ushigakubi, Magaridani, Katoge-mura, Minamikanbara-gun,
Kakuma, Nanatani-mura, Minamikanbara-gun,
Imogawa,Nanatani-mura, Minamikanbara-gun.

TERADOMARI DISTRICT, NIIGATA PREFECTURE, TABLE 13

Localities: Collected by Shinbo and others, 1954, Matsunaga and others, 1955.
Ogi-Aida, Nishigoshi-mura, Santo-gun,
Izumozakimachi, Nishigoshi-mura, Santo-gun,
Izumozakimachi, Teradomari-machi, Santo-gun.

HARANOMACHI DISTRICT, NIIGATA PREFECTURE, TABLE 14

Localities: Collected by Matsuoka, 1952, Shinbo, 1953, and Matsunaga, 1954.
Takegahana, Yoneyama-mura, Nakakubiki-gun,
Kurokawa, Kurokawa-mura, Nakakubiki-gun,
Higashiyokoyama, Kuroiwa-mura, Nakakubiki-gun,
Yoshikawa, Haranomachi, Nakaubiki-gun,
Nagasaki, Meiji-mura, Nakakubiki-gun.

MATSUNOYAMA DISTRICT, NIIGATA PREFECTURE, TABLE 15

Localities: Collected by Matsuoka, 1950, Shinbo, 1954, and Yamada, 1957.
Nunagawa-mura, Higashikubiki-gun,
Mizunashi, Matsunoyama-mura, Higashikubiki-gun,
Koedo River, Matsunoyama, Matsunoyama-mura, Higashikubiki-gun,
Shibumi River, Uratamura-Nunagawamura, Higashikubiki-gun.

WEST TAKADA DISTRICT, NIIGATA PREFECTURE, TABLE 17

Localities: Collected by Matsunaga, 1951, and Shinbo, 1955.
Nadachi River, Nadachi-mura, Nishikubiki-gun,

Kuwatori River, Kuwatorimura-Tanihamamura, Nakakubiki-gun,
Nakanomata River, Tanihama-mura, Nakakubiki-gun.

MAKI DISTRICT, NIIGATA PREFECTERE, TABLE 18

Localities: Collected by Shinbo, 1952, 1954.
Iida River, Maki-mura, Higashikubiki-gun,
Kushiike River, Kushiike-mura, Nakakubiki-gun.

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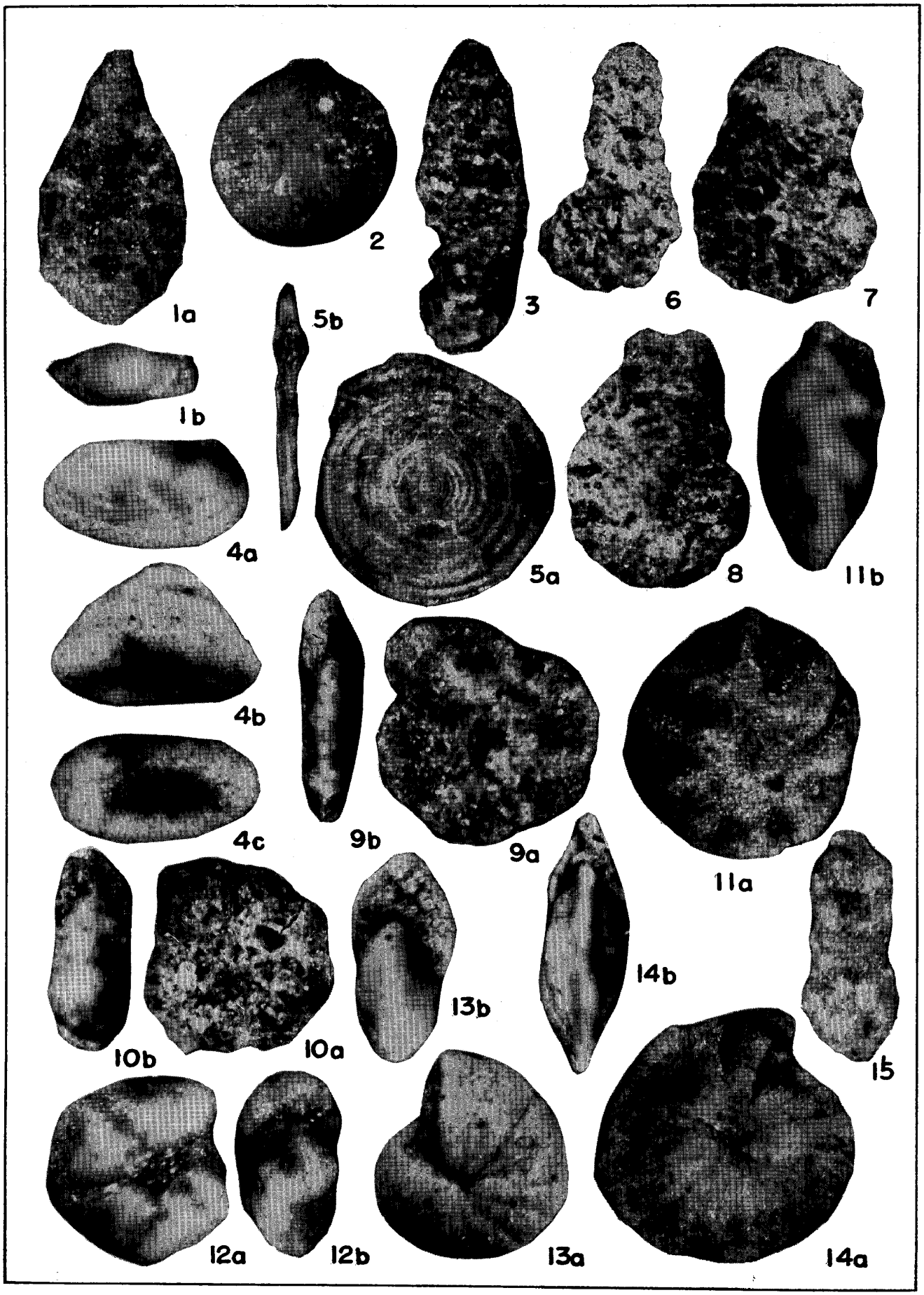
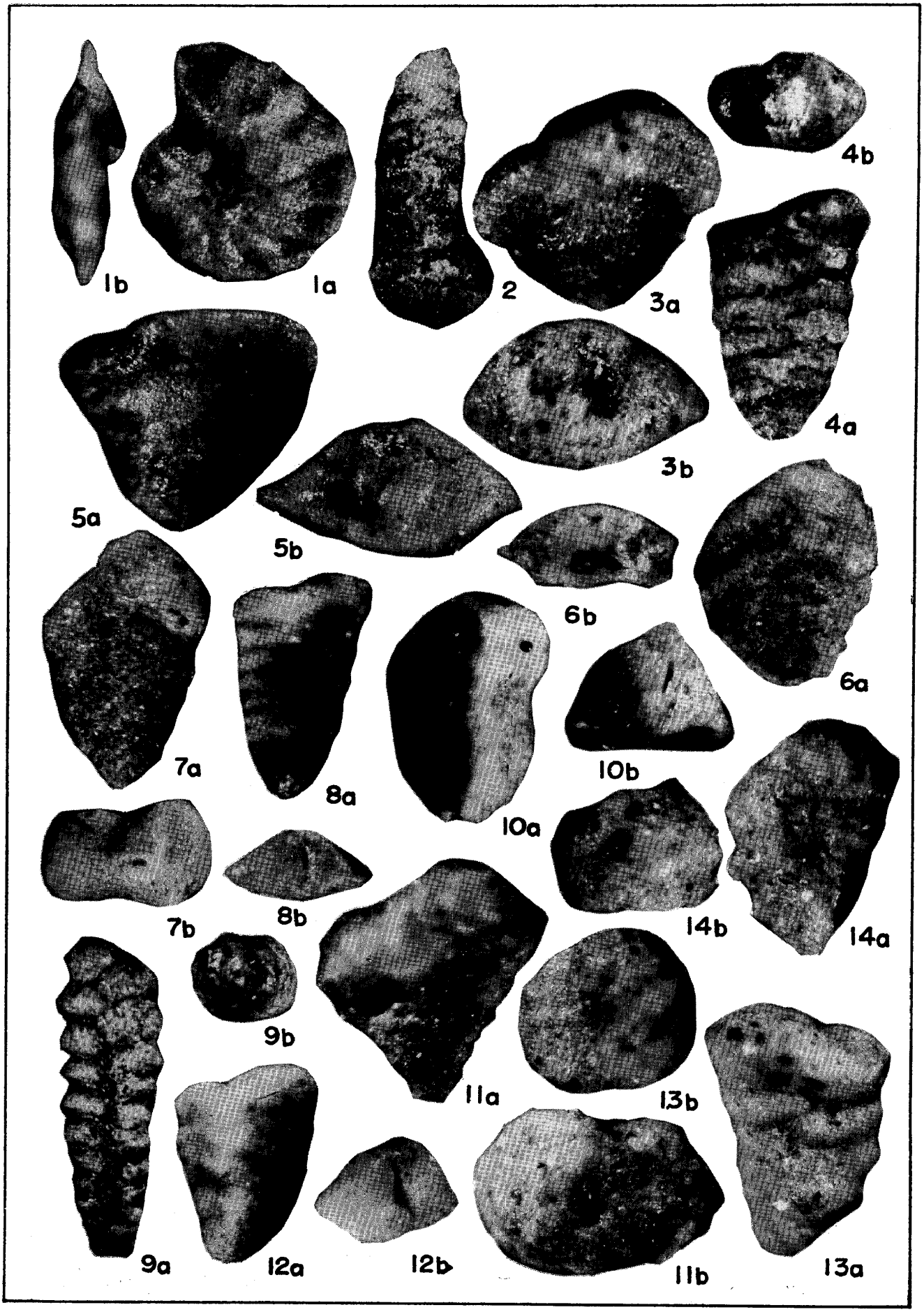
# PLATES 24–52

Plate 24. **Saccamminidae, Reophacidae, Ammodiscidae, Lituolidae, Textulariidae**

Fig. 1. *Proteonina compressa* Cushman and McCulloch, × 79
Kakuda R–1 well; Shiiya formation
Fig. 2. *Saccammina sphaerica* M. Sars, × 50
Koguriyama R–1 well; Shiiya formation
Fig. 3. *Reophax excentricus* Cushman, × 33
Iwata R–1 well, Nishiyama formation
Fig. 4. *Ammodiscoides japonica* Asano and Inomata, × 33
Omo R–95 well, Teradomari formation
Fig. 5. *Ammodiscus incertus* (d'Orbigny), × 8
Teradomari R–1 well, Nanatani formation
Fig. 6. *Ammobaculites catenulatus* Cushman and McCulloch, × 37
Kakuda R–1 well, Shiiya formation
Fig. 7. *Ammobaculites* cf. *formosensis* Nakamura, × 50
Tanaka R–1 well, Shiiya formation
Fig. 8. *Ammobaculites strathearnensis* Cushman and LeRoy, × 33
Yomogidaira, Ota-mura, Koshi-gun, Niigata Prefecture, Higashiyama formation
Fig. 9. *Haplophragmoides compressum* LeRoy, × 33
Matsunoyama R–1 well, Nanatani formation
Fig. 10. *Haplophragmoides* cf. *emaciatum* (Brady), × 37
Yabugami-mura, Minamiuonuma-gun, Niigata Prefecture, Higashiyama formation
Fig. 11. *Haplophragmoides renzi* Asano, × 54
Yahiko R–1, well, Nanatani formation
Fig. 12. *Haplophragmoides* cf. *trullissatum* (Brady), × 79
Nobe River, Koshi-gun, Niigata Prefecture, Higashiyama formation
Fig. 13. *Cyclammina cancellata* Brady, × 21
Yahiko R–1 well, Shiiya formation
Yahiko R–1 well, Nanatani formation
Fig. 15. *Spiroplectammina niigataensis* Asano, × 58
Maze, Maez-mura, Nishikanbara-gun, Niigata Prefecture, Nanatani formation




T. Matsunaga Photo.




T. Matsunaga Photo.

Plate 25. **Lituolidae, Textulariidae, Verneuilinidae**

Fig. 1. *Cyclammina pusilla* Brady, × 62
Yahiko R–1 well, Teradomari formation
Fig. 2. *Spiroplectammina shibataensis* Matsunaga, n. sp., × 62
Shibata R–16 well, Shiiya formation
Fig. 3. *Textularia abbreviata* d'Orbigny, × 68
Sakamachi R–2 well, Ushigakubi formation
Fig. 4. *Textularia agglutinans* d'Orbigny, × 35
Ogi, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation
Fig. 5. *Textularia aokii* Asano, × 55
Inagawa, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation
Fig. 6. *Textularia lythostrota* (Schwager), × 67
Kitakaji R–1 well, Nanatani formation
Fig. 7. *Textularia* (*Siphotextularia*) *saulcyana* d'Orbigny, × 67
Sakamachi R–2 well, Ushigakubi formation
Fig. 8. *Textularia semialata* Cushman, × 56
Inagawa, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation
Fig. 9. *Textularia stricta* Cushman, × 18
Kutta, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation
Fig. 10. *Gaudryina* (*Pseudogaudryina*) *ishikiensis* Asano, × 50
Osawa, Oknabara-mura, Nakakanbara-gun, Niigata Prefecture, Shiroiwa formation
Fig. 11. *Gaudryina karihaensis* Asano, × 57
Fukuma R–1 well, Sasaoka formation
Fig. 12. *Gaudryina* (*Pseudogaudryina*) *niigataensis* Asano, × 47
Kamikotake, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation
Fig. 13. *Gaudryina quadrangularis* Bagg, × 31
Funabashi, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation
Fig. 14. *Gaudryina robusta* Cushman, × 63
Sakamachi R–2 well, Ushigakubi formation

Plate 26. **Verneuilinidae, Valvulinidae, Silicinidae, Miliolidae**



Fig. 1. *Gaudryina yabei* Asano, × 32
Anden, Oga City, Akita Prefecture, Sasaoka formation

Fig. 2. *Gaudryinella japonica* Asano, × 20
Sakamachi R–2 well, Ushigakubi formation

Fig. 3. *Gaudryinella hanzawai* Asano, × 20
Nagaura R–5 well, Shiiya formation

Fig. 4. *Clavulina pacifica* Cushman, × 36
Sakamachi R–2 well, Ushigakubi formation

Fig. 5. *Clavulina yabei akiensis* Asano, × 37
Kurokawatoboku CR–27 well, Ushigakubi formation

Fig. 6. *Goësella schencki* Asano, × 17
Kakuda R–1 well, Shiiya formation

Fig. 7. *Karreriella baccata* (Schwager), × 91
Kitakaji R–1 well, Nanatani formation

Fig. 8. *Karreriella baccata japonica* Asano, × 36
Inagawa, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation

Fig. 9. *Martinottiella communis* (d'Orbigny), × 61
Kakuda R–1 well, Teradomari formation

Fig. 10. *Martinottiella nodulosa* (Cushman), × 29
Fukuma R–1 well, Funakawa formation

Fig. 11. *Plectina nipponica* Asano, × 60
Koguriyama R–1 well, Nanatani formation

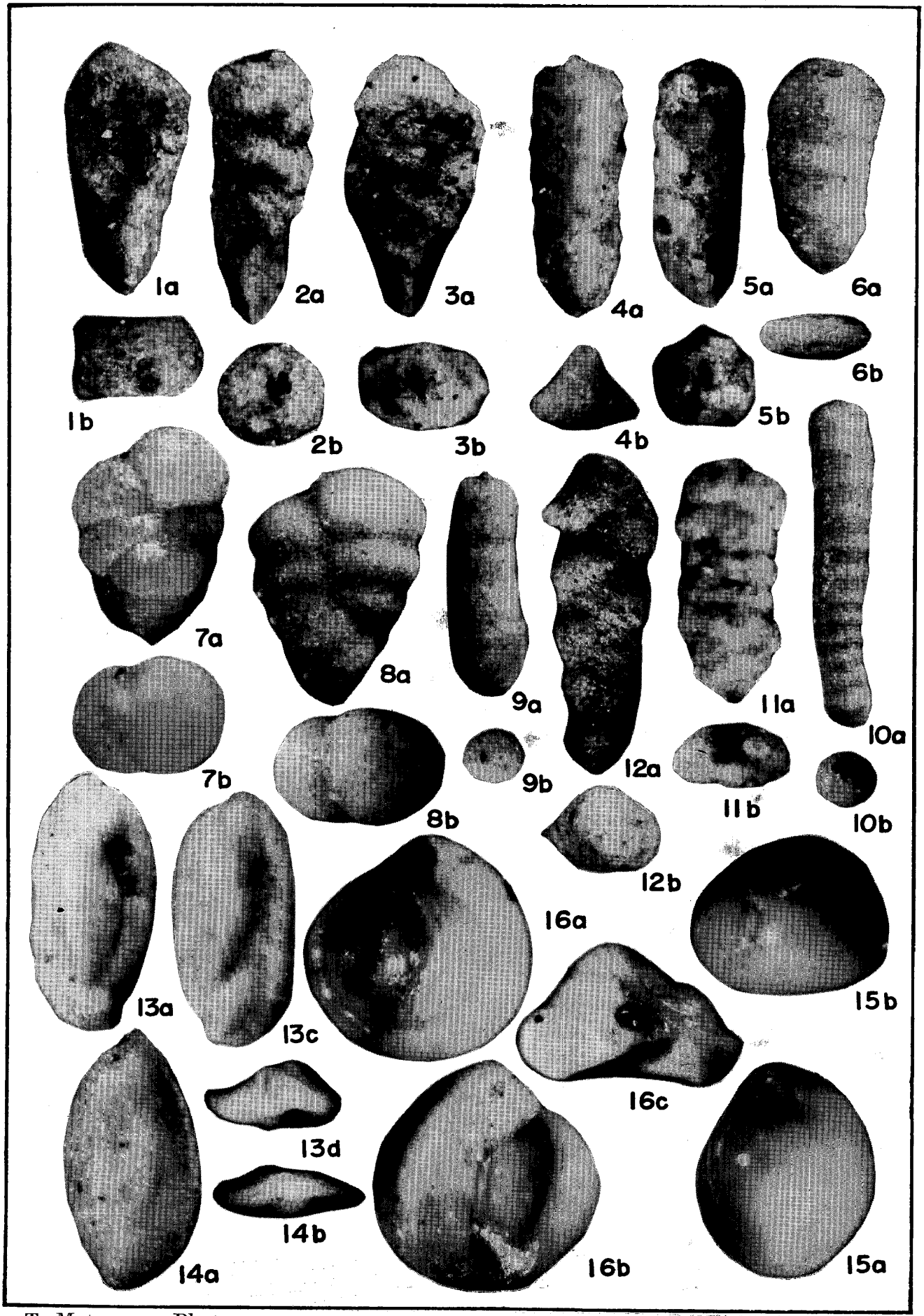
Fig. 12. *Schenckiella victoriensis* (Cushman), × 56
Shibata R–12 well, Ushigakubi formation

Fig. 13. *Miliammina echigoensis* Asano and Inomata, × 72
Fukuura R–1 well, Katsurane formation

Fig. 14. *Spirosigmoilinella compressa* Matsunaga, × 78
Yahiko R–2 well, Katsurane formation

Fig. 15. *Biloculinella natukawa* (Matui and Nakamura), × 78
Yahiko R–1 well, Shiiya formation

Fig. 16. *Quinqueloculina curta* Cushman, × 72
Inagawa, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation

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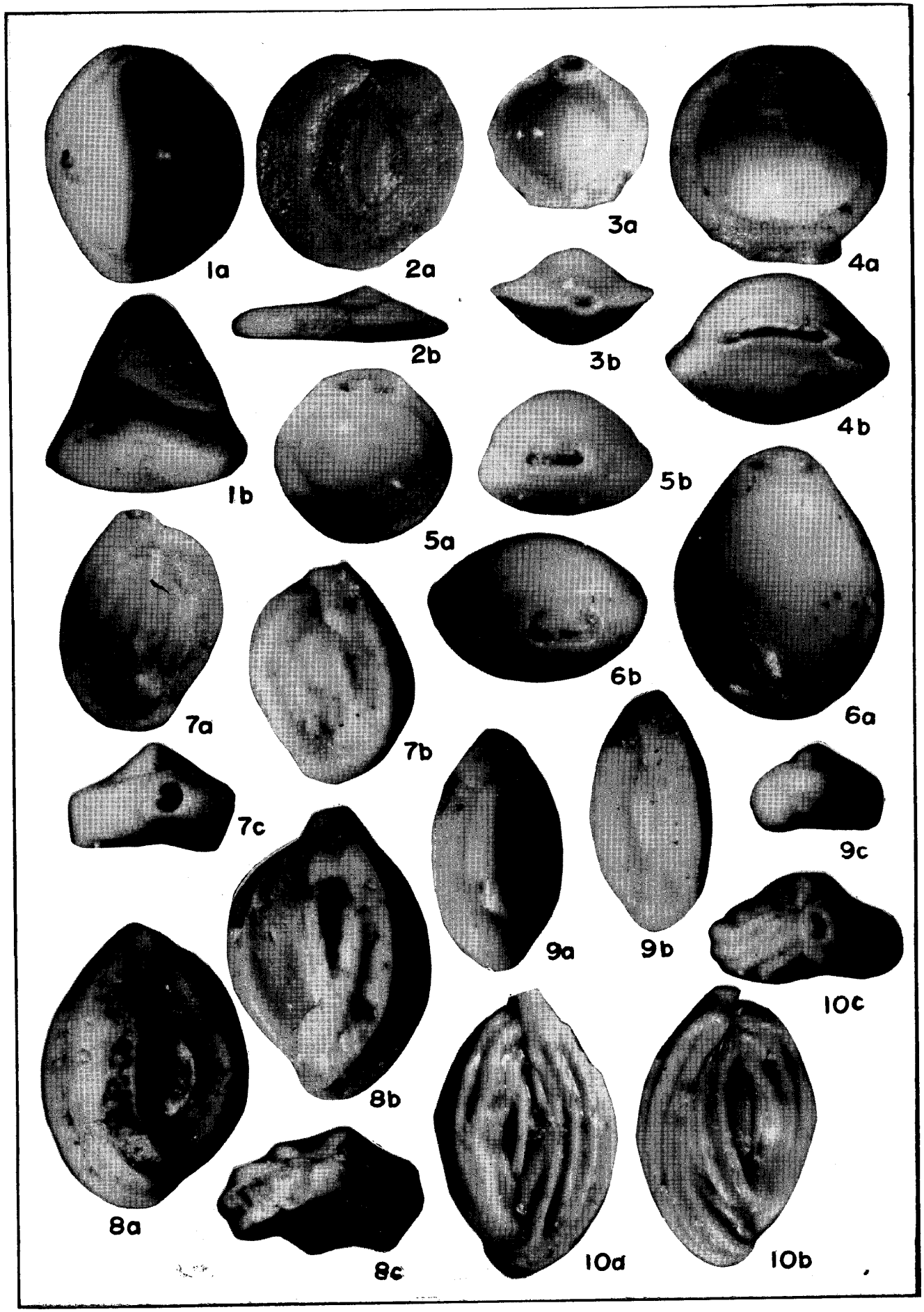


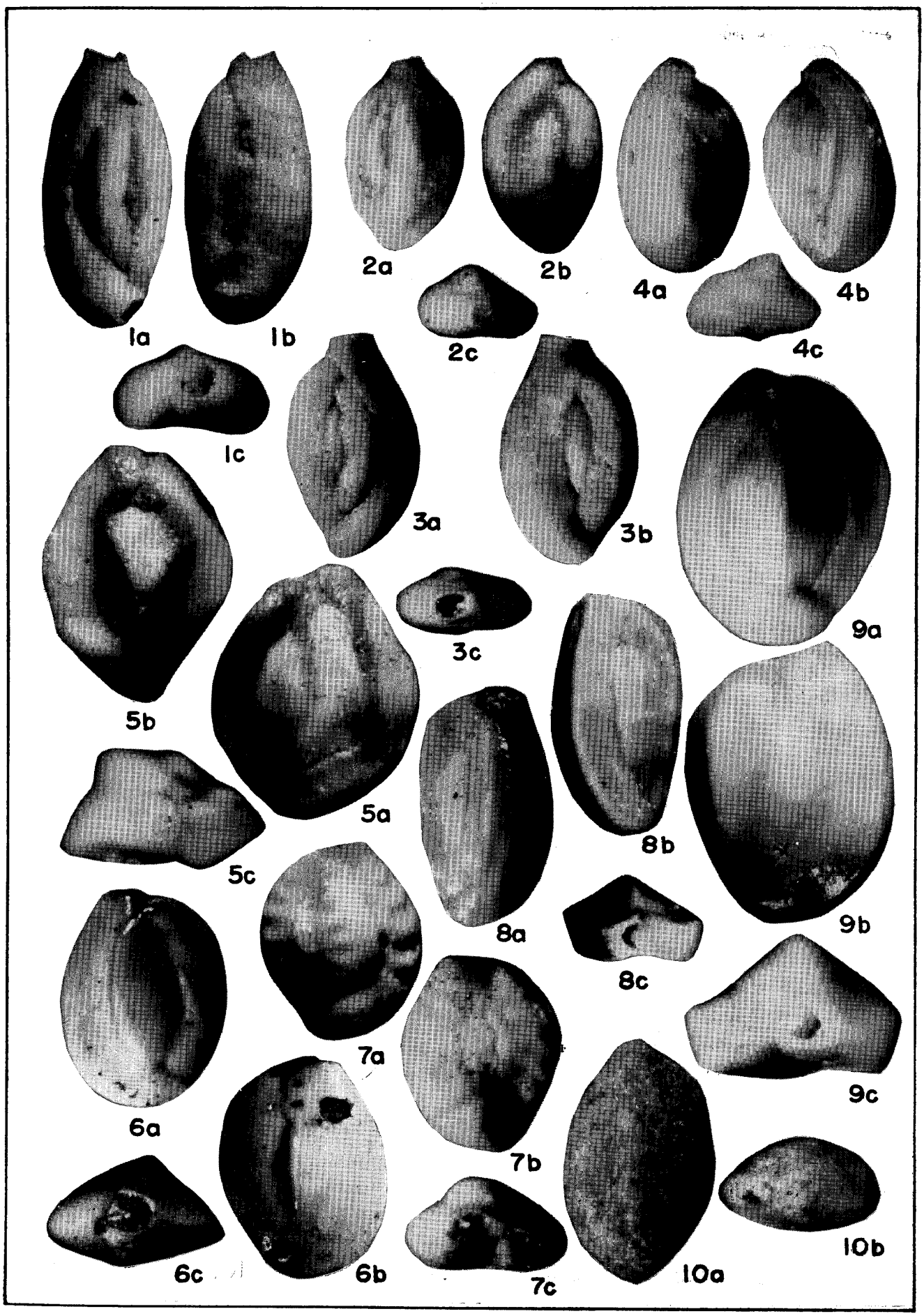

T. Matsunaga Photo.

Plate 27. **Miliolidae**

Fig. 1. *Cruciloculina japonica* Asano, × 22
Niitsu-City, Niigata Prefecture, Shiroiwa formation
Fig. 2. *Hauerina fragilissima* (Brady), × 77
Kamiyamada, Naigo-mura, Kariwa-gun, Niigata Prefecture, Haizume formation
Fig. 3. *Pyrgo murrhina* (Schwager), × 70
Shibata R–1 well, Ushigakubi formation
Fig. 4. *Pyrgo subglobulus* Parr, × 25
Kutta, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation
Fig. 5. *Pyrgo vesperitilio* (Schlumberger), × 43
Inagawa, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation
Fig. 6. *Pyrgo yabei* Asano, × 24
Myogadani, Tagami-mura, Minamikanbara-gun, Niigata Prefecture, Myogadani formation
Fig. 7. *Quinqueloculina agglutinata* Cushman, × 42
Sakamachi R–2 well, Shiroiwa formation
Fig. 8. *Quinqueloculina bicostata* d'Orbigny, × 38
Shibata R–6 well, Haizume formation
Fig. 9. *Quinqueloculina contorta* d'Orbingy, × 47
Inagawa, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation
Fig. 10. *Quinqueloculina costata* d'Orbigny, × 31
Hashida-mura, Nakakanabra-gun, Niigata Prefecture, Shiroiwa formation

Plate 28. **Miliolidae**

Fig. 1. *Quinqueloculina elongata* Natland, × 84
Matsunaga R–1 well, Upper Haizume formation
Fig. 2. *Quinqueloculina* cf. *fulgida* Todd, × 83
Shimada-mura, Santo-gun, Niigata Prefecture, Haizume formation
Fig. 3. *Quinqueloculina hasimotoi* Asano, × 62
Matsunaga R–1 well, Upper Haizume formation
Fig. 4. *Quinqueloculina kuromatunaiensis* Asano, × 95
Anden, Goriai, Oga-City, Akita Prefecture, Tofuiwa formation
Fig. 5. *Quinqueloculina* cf. *lachesis* Karrer, × 77
Ogi, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation
Fig. 6. *Quinqueloculina lamarckiana* d'Orbigny, × 36
Kamijo-mura, Santo-gun, Niigata Prefecture, Haiume formation
Fig. 7. *Quinqueloculina parkeri* (Brady), × 47
Anden, Goriai, Oga-city, Akita Prefecture, Tofuiwa formation
Fig. 8. *Quinqueloculina polygona* d'Orbigny, × 52
Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation
Fig. 9. *Quinqueloculina sawanensis* Asano, × 85
Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation
Fig. 10. *Sigmoilina schlumbergeri* Silvestri, × 67
Aida, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation

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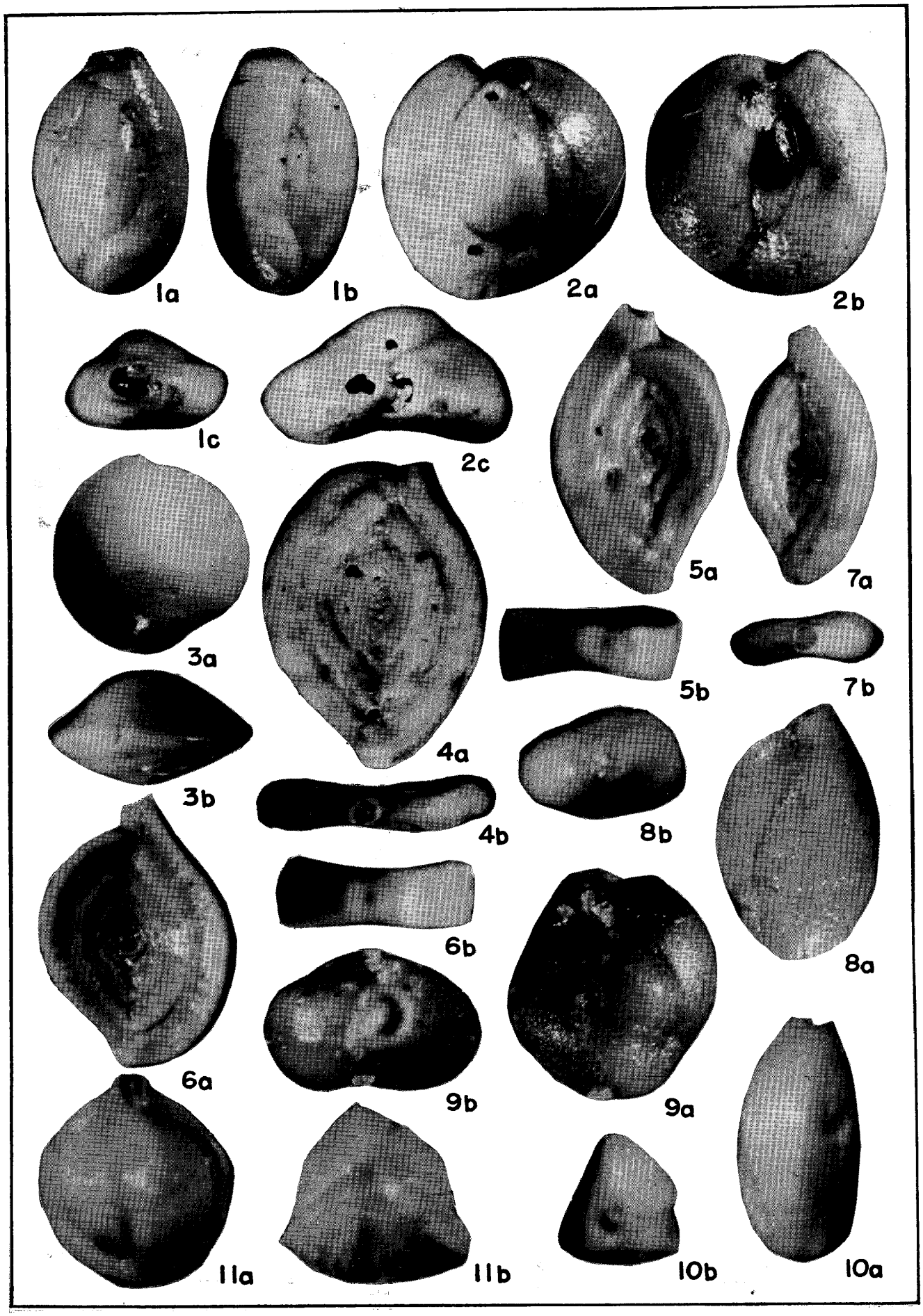


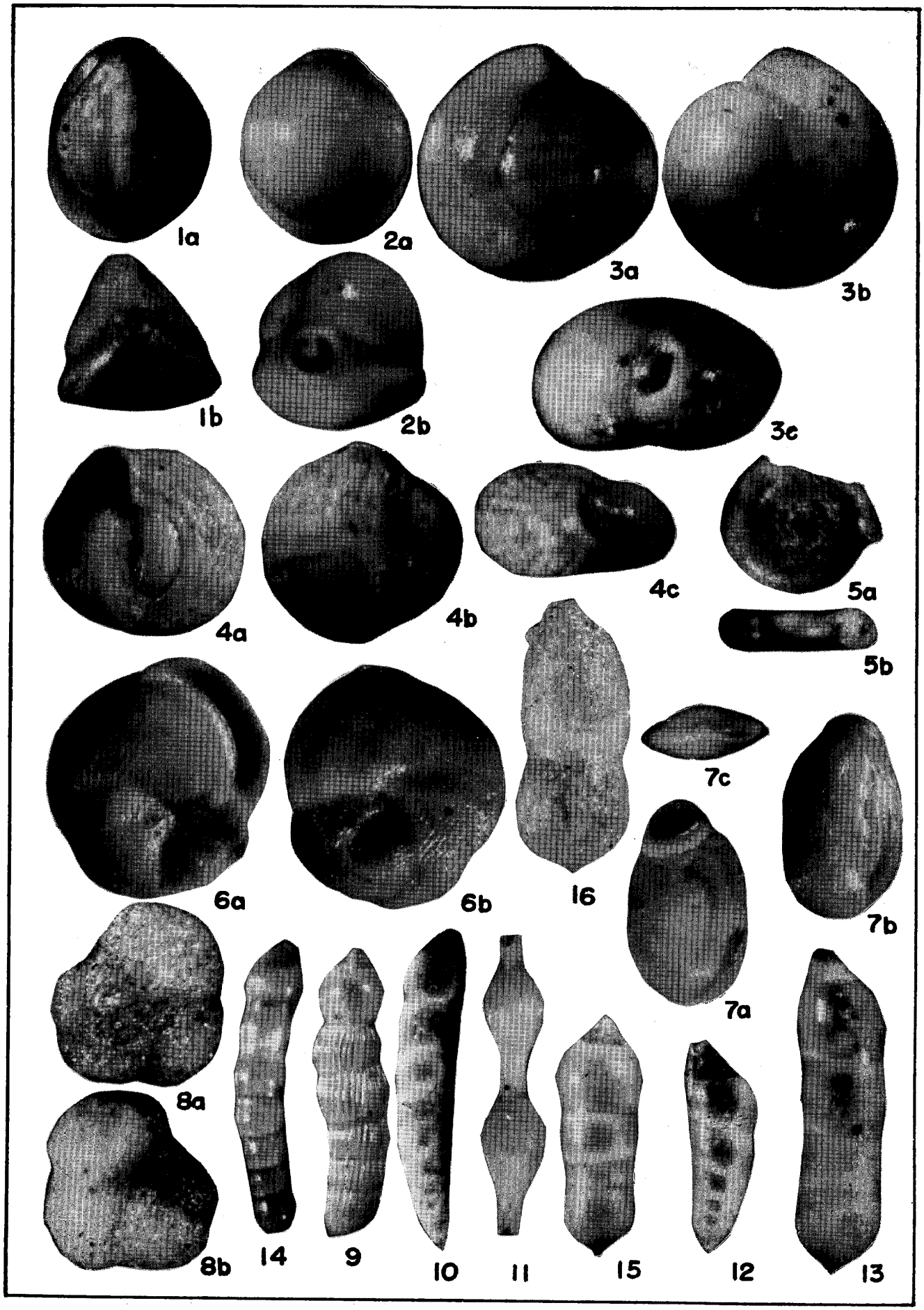

T. Matsunaga Photo.

Plate 29. **Miliolidae**

Fig. 1. *Quinqueloculina seminula* (Linnaeus), × 36
Ogi, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation
Fig. 2. *Quinqueloculina vulgaris* d'Orbigny, × 59
Kakuda R–1 well, Haizume formation
Fig. 3. *Sigmoilina sigmoidea compressa* Cushman, × 65
Kamiyamada, Naigo-mura, Kariwa-gun, Niigata Prefecture, Haizume formation
Fig. 4. *Spiroloculina hadai* Thalman, × 35
Ogi Nishigoshi-mura, Santo-gun, Niigata Prefecture, Funabashi sand
Fig. 5. *Spiroloculina communis* Cushman and Todd, × 36
Hashida-mura, Nakakanbara-gun, Niigata Prefecture, Haizume formation
Fig. 6. *Spiroloculina communis incisa* Cushman, × 37
Hoiishi, Teradomari-machi, Santo-gun, Niigata Prefecture, Haizume formation
Fig. 7. *Spiroloculina corrugata* Cushman and Todd, × 38
Inagawa, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation
Fig. 8. *Triloculina laevigata* d'Orbigny, × 96
Kakuda R–1 well, Shiiya formation
Fig. 9. *Triloculina rotunda* d'Orbigny, × 47
Kamo R–2 well, Ushigakubi formation
Fig. 10. *Triloculina suttuensis* Asano, × 90.
Mikozawa, Kamijo-mura, Kariwa-gun, Niigata Prefecture, Haizume formation
Fig. 11. *Triloculina terquemiana* (Brady), × 46
Ogi, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation

Plate 30. **Miliolidae, Ophthalmidiidae, Trochamminidae, Nodosariidae**

Fig. 1. *Triloculina tricarinata* d'Orbigny, × 47
Kakuda R–1 well, Shiiya formation
Fig. 2. *Triloculina trigonula* (Lamarck), × 42
Inagawa, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation
Fig. 3. *Miliolinella circularis* (Bornemann), × 67
Kakuda R–1 well, Ushigakubi formation
Fig. 4. *Miliolinella sublineata* (Brady), × 36
Inagawa, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation
Fig. 5. *Cornuspira involvens* (Reuss), × 97.
Subiara R–3 well, Ushigakubi formation
Fig. 6. *Vertebralina striata* 'dOrbigny, × 74
Anden, Goriai, Oga-City, Akita Prefecture, Tofuiwa formation
Fig. 7. *Wiesnerella auriculata* (Egger), × 82
Kamiyamada, Naigo-mura, Kariwa-gun, Niigata Prefecture, Haizume formation
Fig. 8. *Trochammina nobensis* Asano, × 80.
Yabukami-mura, Minamiuonuma-gun, Niigata Prefecture, Higashiyama formation
Fig. 9. *Dentalina decepta* (Bagg), × 16
Kurokawatoboku CR–27, well, Shiiya formation
Fig. 10. *Dentalina frobisherensis* Loeblich and Tappan, × 14
Amidase, Shimada-mura, Santo-gun, Niigata Prefecture, Haizume formation
Fig. 11. *Dentalina inflexa* Reuss, × 35
Inagawa, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation
Fig. 12. *Dentalina mucronata* Neugeboren, × 67
Sakamachi R–2 well, Ushigakubi formation
Fig. 13. *Dentalina pauperata* d'Orbigny, × 35
Kakuda R–1 well, Ushigakubi formation
Fig. 14. *Dentalina setanaensis* Asano, × 12
Inagawa, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation
Figs. 15, 16. *Dentalina subsoluta* (Cushman), Fig. 15, × 35; Fig. 16, × 67
Kakuda R–1 well, Ushigakubi formation

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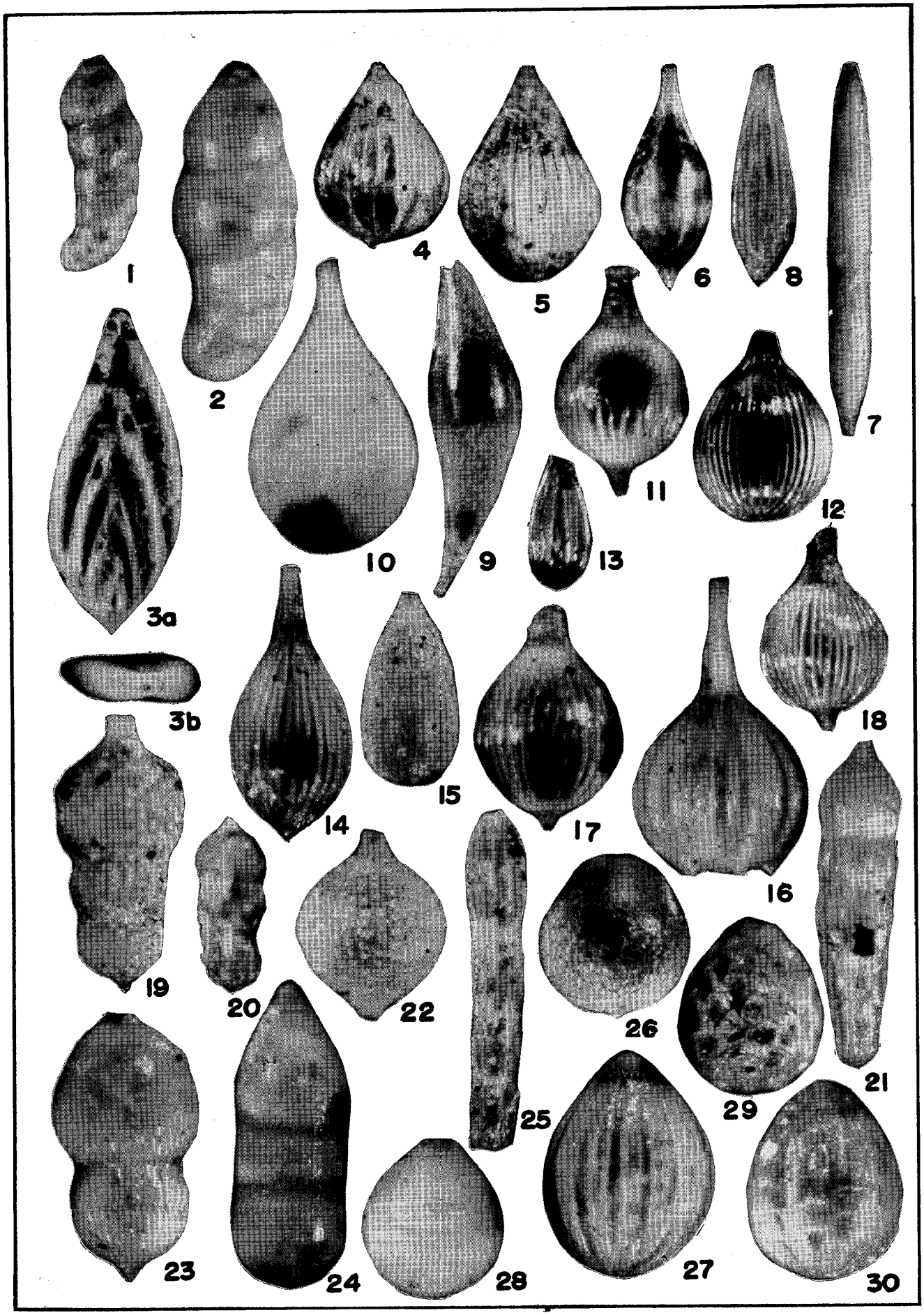


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**Plate 31. Nodosariidae**

Figs. 1, 2. *Dentalina yabei* Asano, Fig. 1, ×17; Fig. 2, ×34
Shimoaosawa, Osawa-mura, Akumi-gun, Yamagata Prefecture, Wakimoto formation

Fig. 3. *Dyofrondicularia nipponica* Asano, × 62
Funakawa-machi, Oga-City, Akita Prefecture, Katsurane formation

Fig. 4. *Lagena apiopleura* Loeblich and Tappan, × 76
Kanazu, Kanazu-mura, Nakakanbara-gun, Niigata Prefecture, Koguchi formation

Fig. 5. *Lagena asanoi* Matsunaga, n. sp., × 78
Osawa, Hashida-mura, Nakakanbara-gun, Niigata Prefecture, Osawa alternation

Fig. 6. *Lagena clavata* (d'Orbigny), × 95
Sakamachi R–3 well, Ushigakubi formation

Fig. 7. *Lagena elongata* (Ehrenberg), × 77
Kamiyaji, Kamishinjo-mura, Minamiakita-gun, Akita Prefecture, Takanosu group

Fig. 8. *Lagena gracilis* Williamson, × 98
Yashikawa, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation

Fig. 9. *Lagena gracillima* (Seguenza), × 89
Kanzau, Kanazu-mura, Nakakanbara-gun, Niigata Prefecture, Koguchi formation

Fig. 10. *Lagena laevis* (Montagu), × 88
Yubiana, Yahiko-mura, Nishikubiki-gun, Niigata Prefecture, Nishiyama formation

Fig. 11. *Lagena semilineata* Wright, × 100
Kamo R–2 well, Ushigakubi formation

Fig. 12. *Lagena semistriata* Williamson, × 100
Dainichi, Suibara-machi, Kitakanbara-gun, Niigata Prefecture, Ushigakubi formation

Fig. 13. *Lagena sesquistriata* Brady, × 98
Yoshikawa, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation

Fig. 14. *Lagena* sp., × 233
Kutta, Shimada-mura, Santo-gun, Niigata Prefecture, Haizume formation

Fig. 15. *Lagena substriata* Williamson, × 97
Nagao, Funagata-mura, Mogami-gun, Yamagata Prefecture, Kusanagi formation

Fig. 16. *Lagena sulcata laevicostata* Cushman and Gray, × 94
Kamiyagi, Kamishinjo-mura, Minamiakita-gun, Akita Prefecture, Sasaoka formation

Figs. 17, 18. *Lagena sulcata spicata* Cushman and McCulloch, Fig. 17, × 115; Fig. 18, × 71
Sasaoka-mura, Kitakanbara-gun, Niigata Prefecture, Shiroiwa formation

Fig. 19. *Lagenonodosaria aculeata* (d'Orbigny), × 42
Kitakaji R–1 well, Nanatani formation

Figs. 20, 21. *Lagenonodosaria fukushimaensis* Asano, Fig. 20, × 31; Fig. 21, × 31
Nagasawa, Funagata-mura, Kusanagi formation and Kamabuchi, Nozoki-mura, Mogami-gun, Yamagata Prefecture, Furukuchi formation

Fig. 22. *Lagenonodosaria hirsuta* (d'Orbigny), × 49
Kitakaji R–1 well, Nanatani formation

Fig. 23. *Lagenonodosaria scalaris sagamiensis* Asano, × 90
Iwata R–1 well, Nishiyama formation

Fig. 24. *Nodosaria emphysaocyta* Loeblich and Tappan, × 52
Kamo R–2 well, Ushigakubi formation

Fig. 25. *Nodosaria* cf. *raphana* (Linnaeus), × 62
Shibata R–2 well, Shiiya formation

Fig. 26. *Oolina ampulla-distoma* (Jones), × 83
Yoshikawa, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation

Fig. 27. *Oolina costata* (Williamson), × 76
Kakuda R–1 well, Ushigakubi formation

Fig. 28. *Oolina globosa* (Montagu), × 37
Kanazu, Kanazu-mura, Nakakanbara-gun, Niigata Prefecture, Koguchi formation

Fig. 29. *Oolina hexagona* (Williamson), × 87
Nodaigawa R–1 well, Ushigakubi formation

Fig. 30. *Oolina melo* d'Orbigny, × 97
Kamo R–2 well, Ushigakubi formation

## Plate 32 Nodosariidae

Fig. 1. *Oolina oinomikadoi* Matsunaga, n. sp. × 67
Inagawa, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation

Fig. 2. *Planularia planulata* (Galloway and Wissler), × 79
Takatateyama, Hashida-mura, Nakakanbara-gun, Niigata Prefecture, Shiroiwa formation

Fig. 3. *Planularia tricarinella* (Reuss), × 39
Yoita-machi, Santo-gun, Niigata Prefecture, Nishiyama formation

Fig. 4. *Plectofrondicularia japonica* Asano, × 57
Kitakaji R–1 well, Nanatani formation

Fig. 5. *Plectofrondicularia miocenica* Cushman, × 62
Shibata R–15 well, Ushigakubi formation

Fig. 6. *Pseudoglandulina acuta* LeRoy, × 67
Koguchi, Niigata-City, Nakakanbara-gun, Niigata Prefecture, Shirowia formation

Fig. 7. *Saracenaria schencki* Cushman and Hobson, × 32
Shibata R–12 well, Ushigakubi formation

Fig. 8. *Fissurina circulo-costa* Asano, × 107
Makihara, Wakino-machi, Santo-gun, Niigata Prefecture, Nishiyama formation

Fig. 9. *Fissurina cucurbitasema* Loeblich and Tappan, × 114
Suibara R–3 well, Higashiyama formation

Fig. 10. *Fissurina echigoensis* (Asano and Inomata), × 138
Suibara R–3 well, Shiiya formation

Fig. 11. *Fissurina exsculpta* (Brady), × 110
Kakuda R–1 well, Shiiya formation

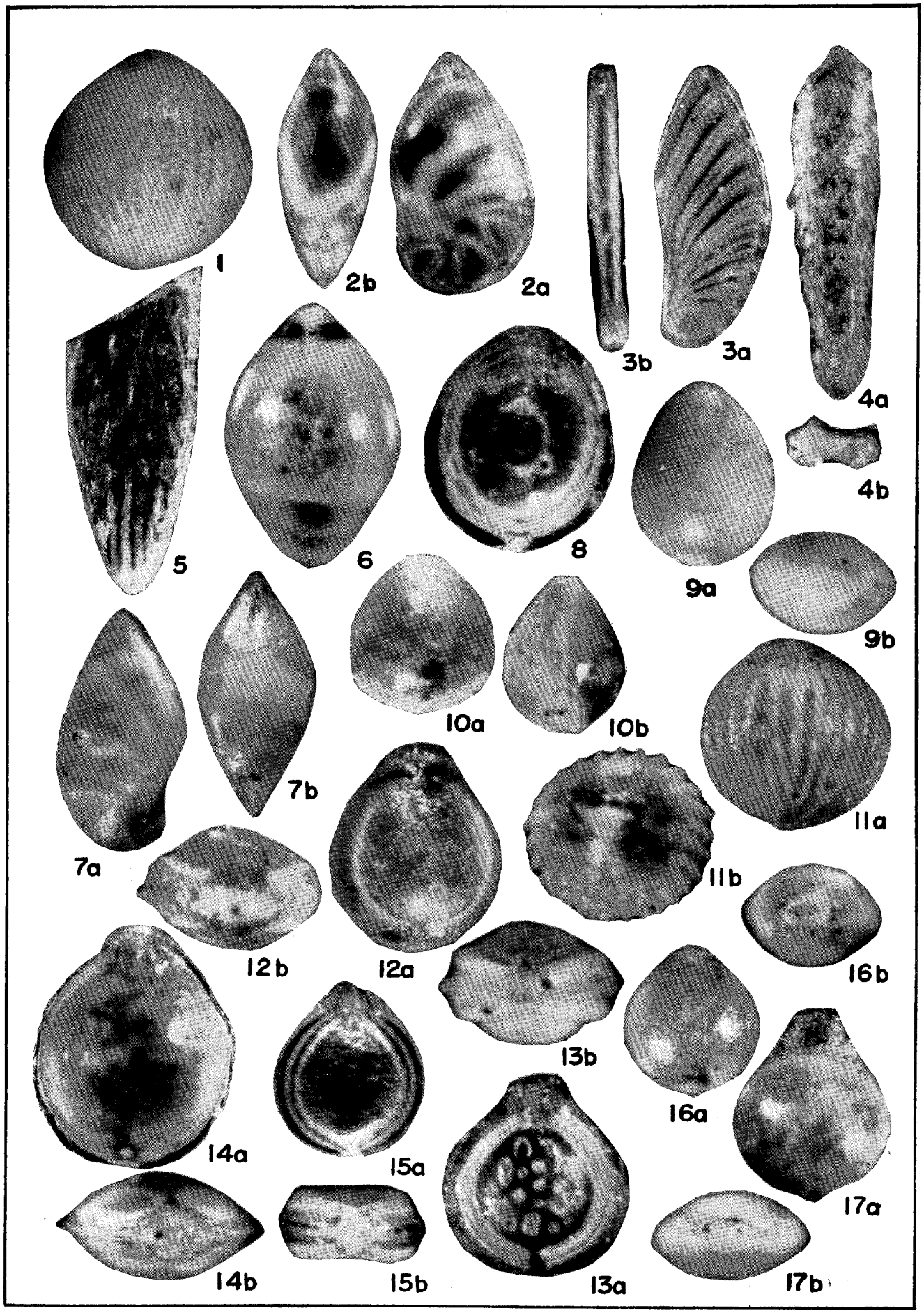
Fig. 12. *Fissurina faciata* (Egger), × 120
Kamo R–2 well, Shiiya formation

Fig. 13. *Fissurina lacunata* (Burrows and Holland), × 118
Nodaigawa R–1 well, Ushigakubi formation

Fig. 14. *Fissurina marginata* (Montagu), × 60
Fukuura R–3 well, Tentokuji formation

Fig. 15. *Fissurina* cf. *orbignyana* Seguenza, × 125
Kamo R–X well, Nishiyama formation

Figs. 16, 17. *Fissurina semimarginata* (Reuss), Fig. 16, × 77; Fig. 17. × 80
Kutta, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation, and Kamo R–2 well, Nishiyama formation

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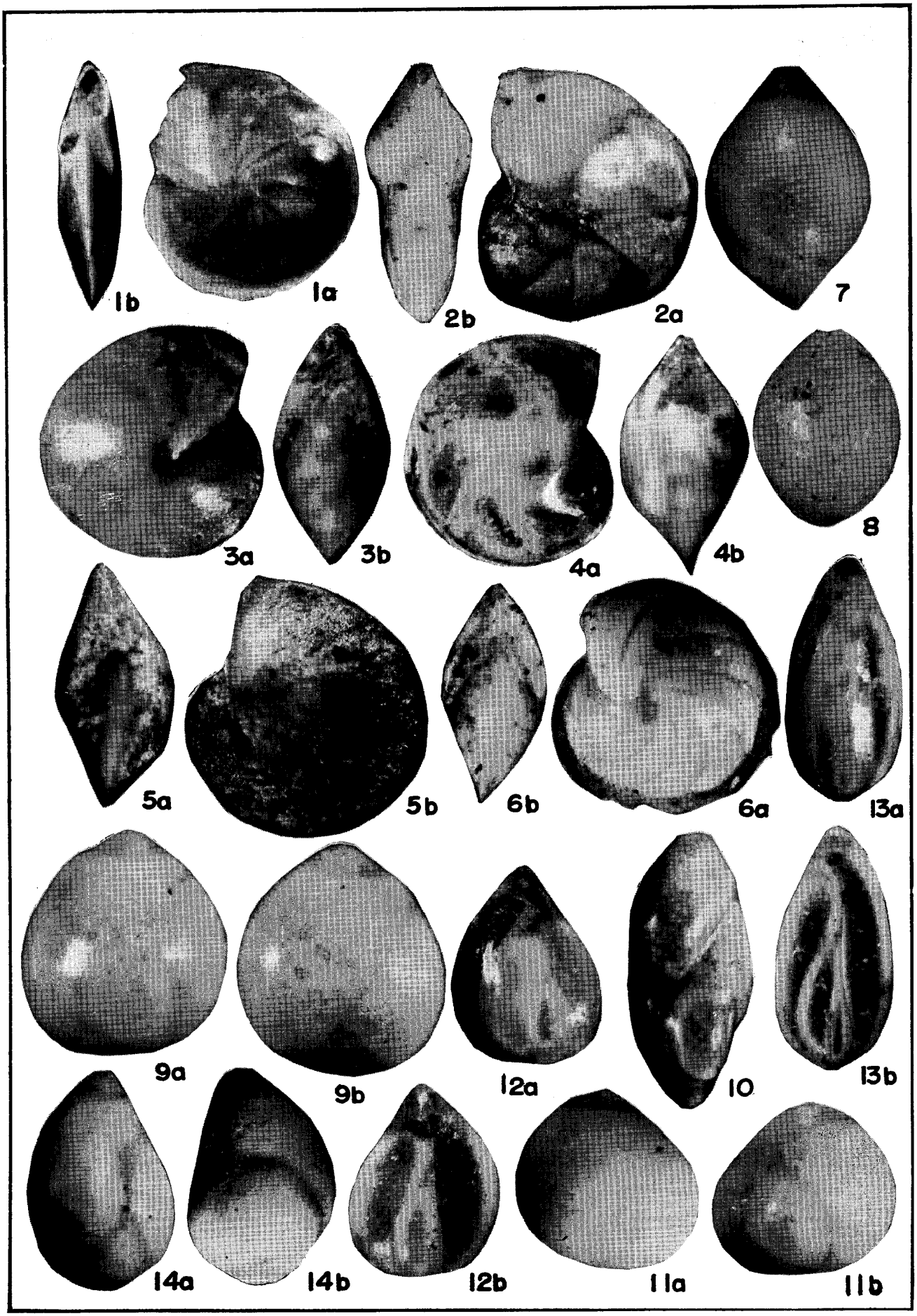


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Plate 33. **Nodosariidae, Polymorphinidae**

Fig. 1. *Robulus* cf. *depressus* Asano, × 15
Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation

Fig. 2. *Robulus depressus naigoensis* Matsunaga, n. subsp., × 45
Haizume, Naigo-mura, Kariwa-gun, Niigata Prefecture, Haizume formation

Fig. 3. *Robulus etiogensis* Asano, × 27
Sakamachi R–2 well, Ushigakubi formation

Fig. 4. *Robulus lucidus* (Cushman), × 92
Asahi, Kanazu-mura, Nakakanbara-gun, Niigata Prefecture, Shiroiwa formation

Fig. 5. *Robulus nikobarensis* (Schwager), × 26
Funabashi, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation

Fig. 6. *Robulus orbicularis* (d'Orbigny), × 27
Inagawa, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation

Fig. 7. *Glandulina nipponica* Asano, × 8
Shibata R–15 well, Ushigakubi formation

Fig. 8. *Globulina gibba* d'Orbigny, × 22
Osawa, Funagata-mura, Mogami-gun, Yamagata Prefecture, Kusanagi formation

Fig. 9. *Globulina landesi* (G.D. Hanna and M.A. Hanna), × 68
Jorakuji, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation

Fig. 10. *Guttulina austriaca* d'Orbigny, × 37
Myogadani, Tagami-mura, Minamikanbara-gun, Niigata Prefecture, Ushigakubi formation

Fig. 11. *Guttulina bulloides* (Reuss), × 41
Kamikatake, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation

Fig. 12. *Guttulina irregularis nipponensis* Cushman and Ozawa, × 42
Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation

Fig. 13. *Guttulina kishinouyi* Cushman and Ozawa, × 49
Fukuura R–1 well, Sasaoka formation

Fig. 14. *Guttulina orientalis* Cushman and Ozawa, × 32
Myogadani, Tagami-mura, Minamikanbara-gun, Niigata Prefecture, Ushigakubi formation

Plate 34. **Polymorphinidae**

Figs. 1, 2. *Guttulina* (*Sigmoidina*) *pacifica* (Cushman and Ozawa), Fig. 1, × 72; Fig. 2, × 64
Daidokaji R–17 well, Ushigakubi formation and Kamo R–2 well, Ushigakubi formation

Fig. 3. *Guttulina sadoensis* (Cushman and Ozawa), × 388
Sakamachi R–3 well, Ushigakubi formation

Figs. 4, 5. *Guttulina yabei* Cushman and Ozawa, × 39
Inagawa, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation and Kutta, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation

Fig. 6. *Guttulina yamazakii* Cushman and Ozawa, × 25
Inagawa, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation

Figs. 7, 8. *Polymorphina charlottensis* Cushman, Fig. 7, × 19; Fig. 8, × 19
Shimoaosawa, Osawa-mura, Akumi-gun, Yamagata Prefecture, Kannonji formation and Oga-City, Akita Prefecture, Sasaoka formation

Fig. 9. *Polymorphina kincaidi* Cushman and Todd, × 38
Tajiri-mura, Kariwa-gun, Niigata Prefecture, Haizume formation

Fig. 10. *Polymorphina yabei* Asano, × 19
Daidokaji R–17 well, Ushigakubi formation

Fig. 11. *Pseudopolymorphina* cf. *dollfussi tenuistriata* Cushman and Ozawa, × 41
Sado C–1 well, Nishiyama formation

Fig. 12. *Pseudopolymorphina hanzawai* Cushman and Ozawa, × 22
Inagawa, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation

Fig. 13. *Pseudopolymorphina indica* (Cushman), × 33
Haizume, Naigo-mura, Kariwa-gun, Niigata Prefecture, Haizume formation

Fig. 14. *Pseudopolymorphina indica japonica* Cushman and Ozawa, × 16
Haizume, Naigo-mura, Kariwa-gun, Niigata Prefecture, Haizume formation

Fig. 15. *Pseudopolymorphina ishikawaensis* Cushman and Ozawa, × 36
Kamiyaji, Kamishinjo-mura, Minamiakita-gun, Akita Prefecture, Tofuiwa formation

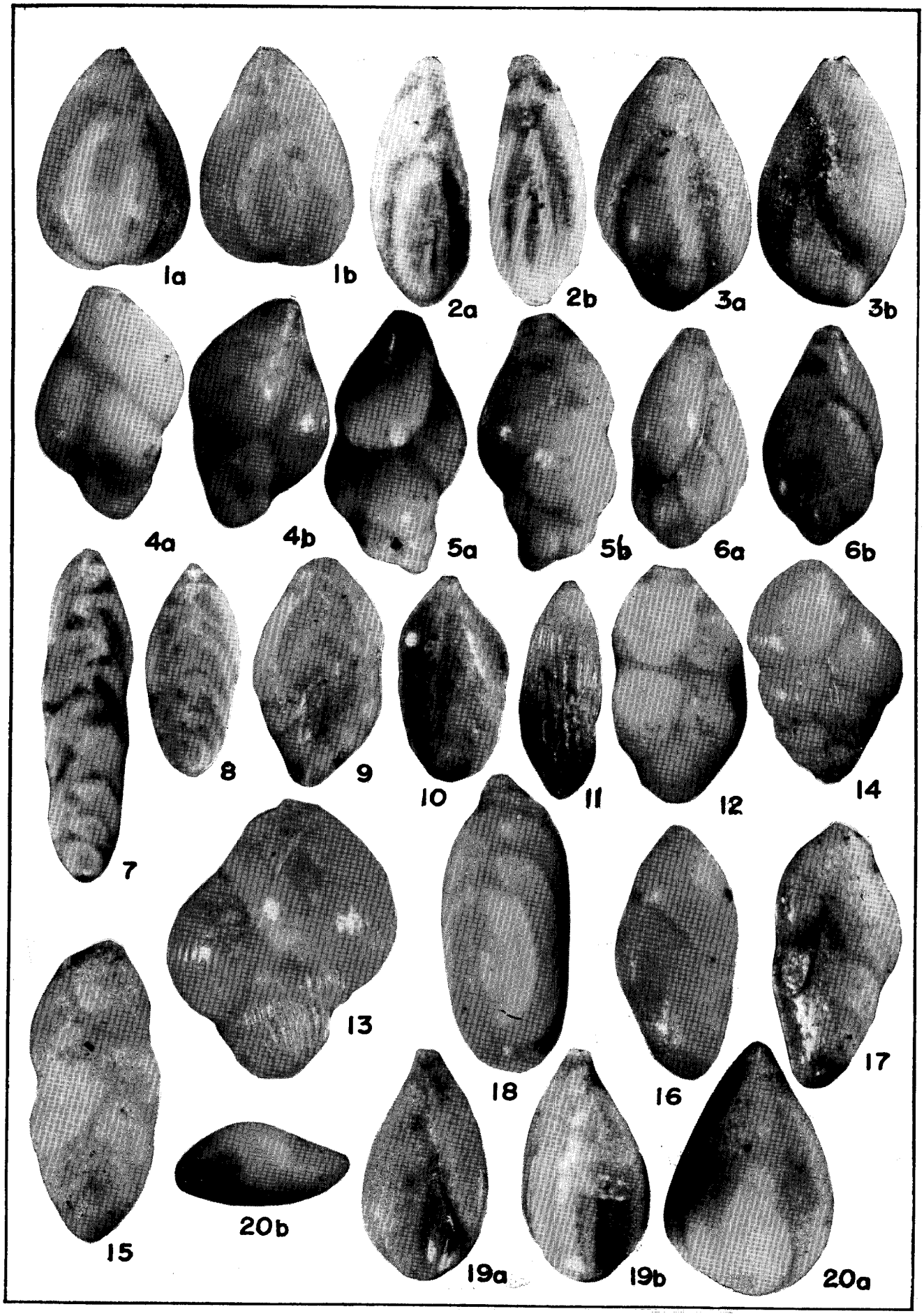
Fig. 16. *Pseudopolymorphina okuwaensis* Cushman and Ozawa, × 46
Ogi, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation

Fig. 17. *Pseudopolymorphina suboblonga* Cushman and Ozawa, × 22
Kutta, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation

Fig. 18. *Sigmoidella kagaensis* Cushman and Ozawa, × 37
Daidokaji R–8 well, Ushigakubi formation

Fig. 19. *Sigmomorphina ozawai* (Hada), × 43
Osawa-mura, Akumi-gun, Yamagata Prefecture, Kannonji formation

Fig. 20. *Sigmomorphina sawanesis* (Cushman and Ozawa), × 39
Kanazu, Kanazu-mura, Nakakanbara-gun, Niigata Prefecture, Koguchi formation

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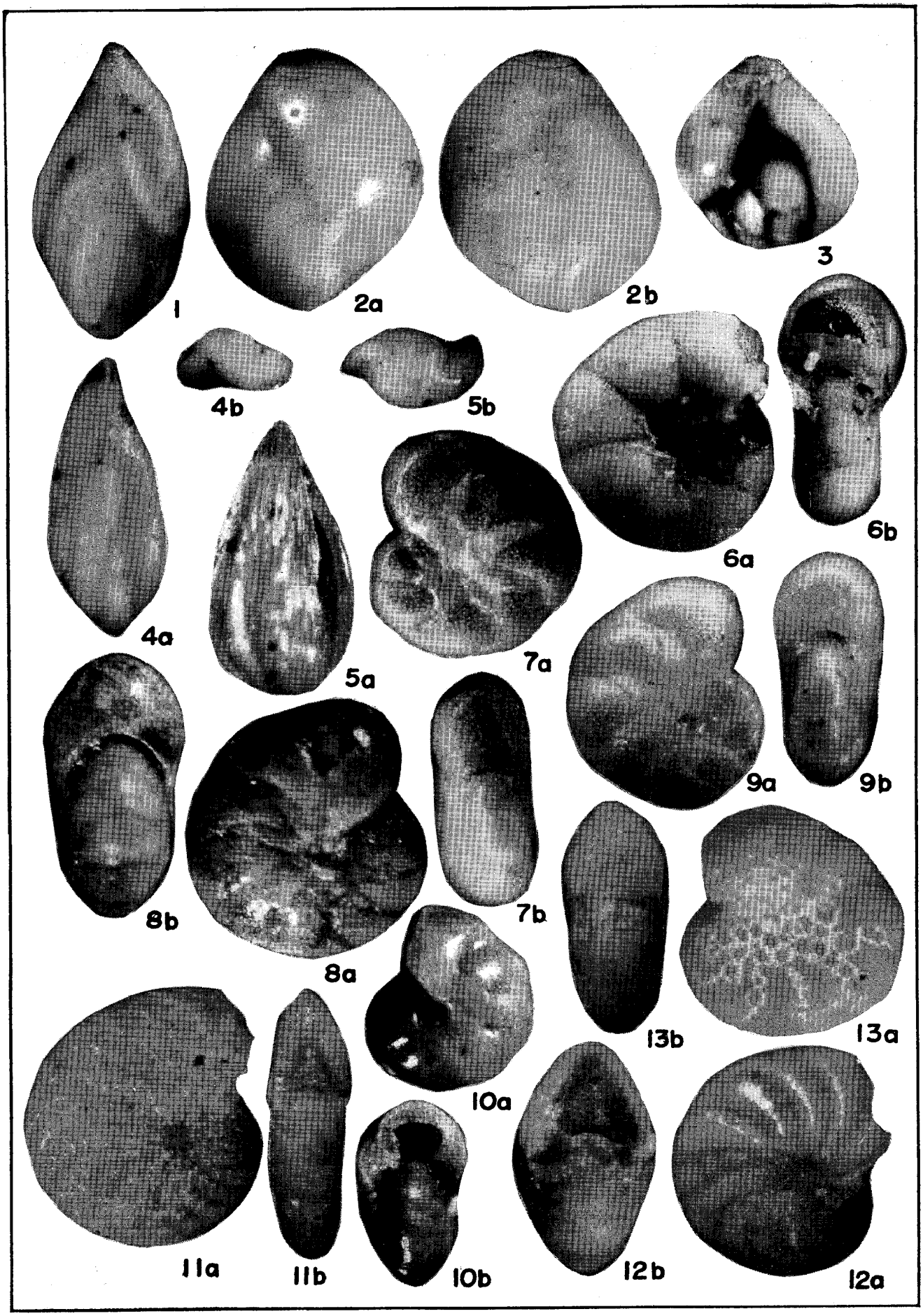


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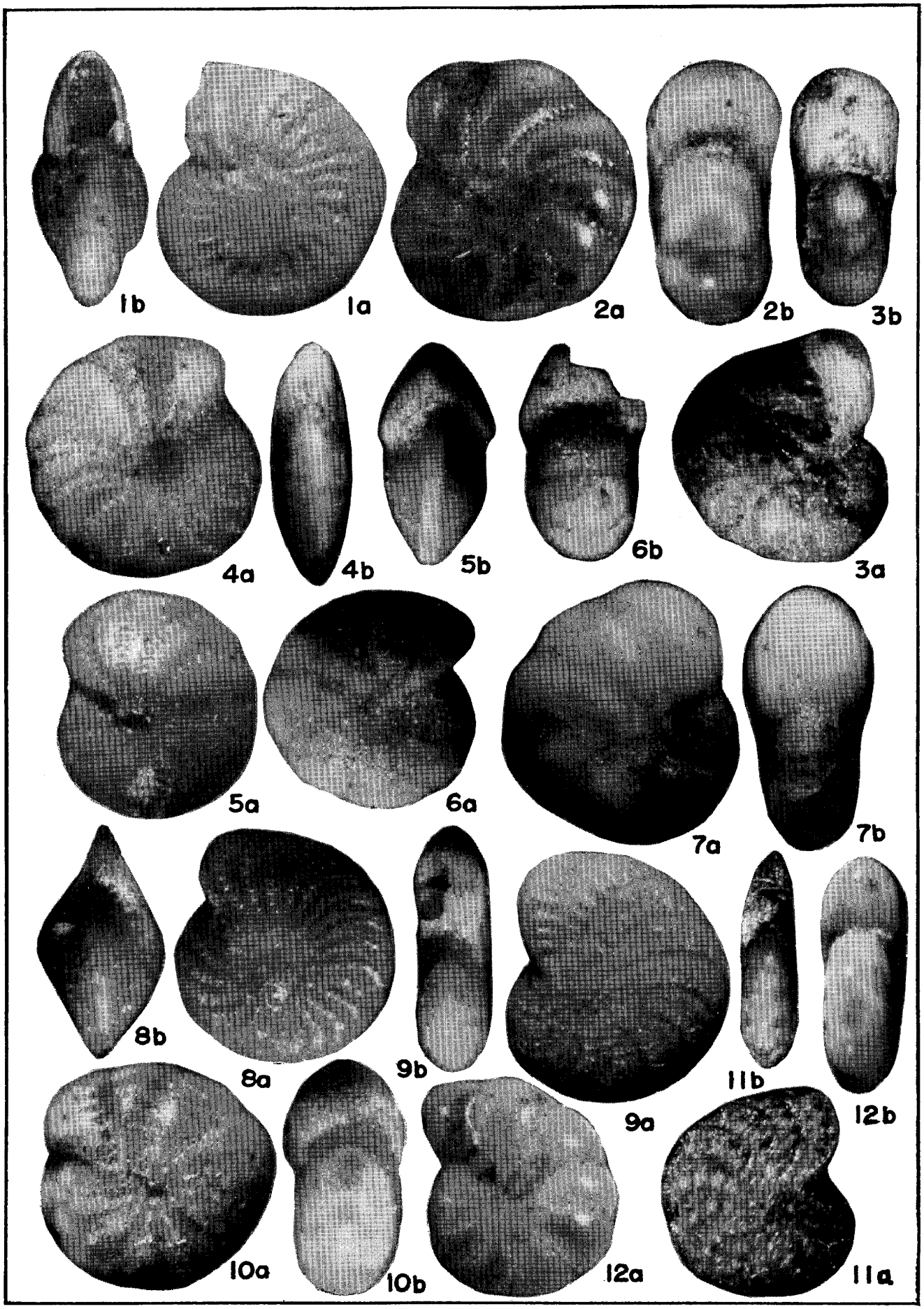
Plate 35. **Polymorphinidae, Nonionidae**

Fig. 1. *Sigmomorphina nagaoi* Asano, × 41
Kanazu, Kanazu-mura, Nakakanbara-gun, Niigata Prefecture, Koguchi formation
Fig. 2. *Sigmomorphina* cf. *semitecta* (Reuss), × 42
Kamikotake, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation
Fig. 3. *Sigmomorphina setanaenesis* Asano, × 22
Kutta, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation
Fig. 4. *Sigmomorphina trilocularis* (Bagg), × 60
Inagawa, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation
Fig. 5. *Sigmomorphina yokoyamai* Cushman and Ozawa, × 64
Fukuura R–1 well, Sasaoka formation
Fig. 6. *Astrononion aomoriense* Asano, × 58
Hachimori R–51 well, Tentokuji formation
Fig. 7. *Astrononion hamadaense* Asano, × 125
Yoita-machi, Santo-gun, Niigata Prefecture, Nishiyama formation
Fig. 8. *Astrononion hanyudaense* Matsunaga, n. sp., × 108
Hanyuda R–1 well, Shirowia formation
Fig. 9. *Astrononion* cf. *stelligerum* (d'Orbigny), × 125
Shimada-mura, Santo-gun, Niigata Prefecture, Haizume formation
Fig. 10. *Astrononion umbilicatulum* Uchio, × 102
Diadokaji R–17 well, Ushigakubi formation
Fig. 11. *Cribroelphidium cribrojenseni* Matsunaga, n. sp., × 72
Yahiko R–1 well, Shiiya formation
Fig. 12. *Cribroelphidium kannonjiense* Matsunaga, n. sp., × 47
Kannonji-mura, Akumi-gun, Yamagata Prefecture, Kannonji formation
Fig. 13. *Cribroelphidium nishiyamaense* Matsunaga, n. sp., × 47
Nishiyama-mura, Kariwa-gun, Niigata Prefecture, Haizume formation

Plate 36 **Nonionidae**

Fig. 1. *Cribroelphidium ezoense* (Asano), × 22
Kannonji-mura, Akumi-gun, Yamagata Prefecture, Kannonji formation
Fig. 2. *Cribroelphidium yabei* (Asano), × 73
Kamo R–2 well, Ushigakubi formation
Fig. 3. *Elphidiella nagaoi* Asano, × 45
Iidera, Kashiwazaki City, Niigata Prefecture, Haizume formation
Fig. 4. *Elphidium advenum* Cushman, × 58
Inagawa, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation
Fig. 5. *Elphidium advenum depressulum* Cushman, × 61
Daidokaji R–17 well, Shiroiwa formation
Fig. 6. *Elphidium asanoi* Matsunaga, × 92
Sakai, Kurokawa-mura, Kitakanbara-gun, Niigata Prefecture, Tsugawa formation
Fig. 7. *Elphidium etiogense* Husezima and Maruhasi, × 76
Funabashi, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation
Fig. 8. *Elphidium fax barbarense* Nicol, × 67
Nodaigawa R–1 well, Ushigakubi formation
Fig. 9. *Elphidium hanzawai* Asano, × 63
Funabashi, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation
Fig. 10. *Elphidium hughesi foraminosum* Cushman, × 71
Iwata R–1 well, Haizume formation
Fig. 11. *Elphidium jenseni* (Cushman), × 92
Nodaigawa R–1 well, Haizume formation
Fig.12. *Elphidium subincertum* Asano, × 62
Yukyuzan, Nagaoka City, Niigata Prefecture, Shiroiwa formation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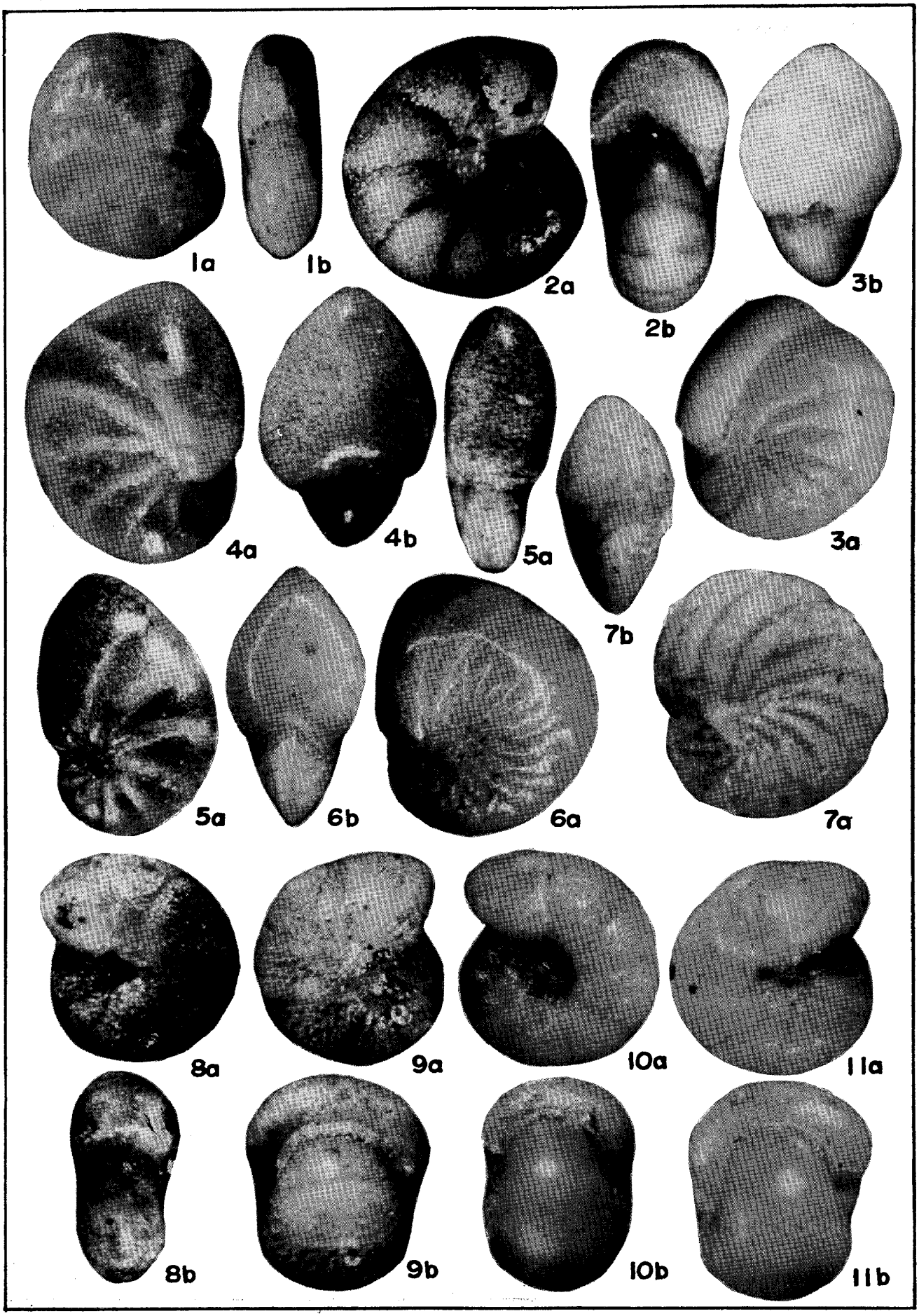



T. Matsunaga Photo.

Plate 37. **Nonionidae**

Fig. 1. *Elphidium kusiroense* Asano, × 92
Inagawa, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation

Fig. 2. *Nonion aimonoi* Matsunaga, n. sp., × 107
Oshima-mura, Higashikubiki-gun, Niigata Prefecture, Haizume formation

Fig. 3. *Nonion japonicum* Asano, × 57
Kamiyachi, Kamishinjo-mura, Minamiakita-gun, Akita Prefecture, Sasaoka formation

Fig. 4. *Nonion labradricum* (Dawson), × 87
Sakamachi R–2 well, Ushigakubi formation

Fig. 5. *Nonion grateloupi* (d'Orbigny), × 109.
Sakamachi R–2 well, Ushigakubi formation

Fig. 6. *Nonion manpukujiense* Otsuka, × 73
Shibata R–13 well, Shiroiwa formation

Fig. 7. *Nonion nagasawaense* Matsunaga, n. sp., × 59
Nagasawa-mura, Mogami-gun, Yamagata Prefecture, Kusanagi formation

Fig. 8. *Nonion pacificum* (Cushman), × 117
Kitakaji R–1 well, Nanatani formation

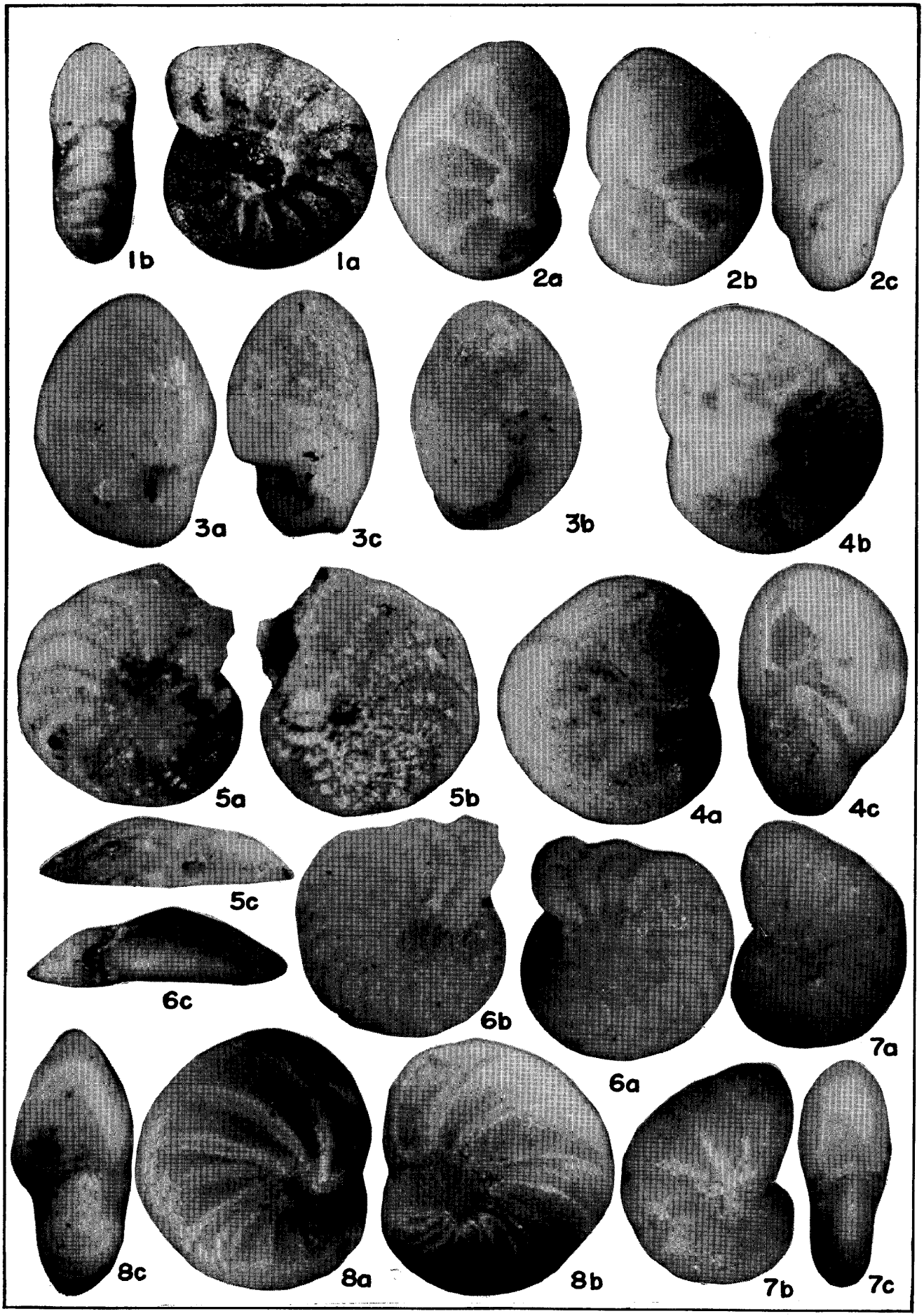
Fig. 9. *Nonion pompilioides* (Fichtel and Moll), × 88
Kakuda R–1 well, Nishiyama formation

Fig. 10. *Nonion pompilioides shimokinense* Asano, × 60
Nagasawa-mura, Mogami-gun, Yamagata Prefecture, Kusanagi formation

Fig. 11. *Nonion soldanii* (d'Orbigny), × 75
Shibata R–12 well, Ushigakubi formation

Plate 38. **Nonionidae**

Fig. 1. *Nonion nicobarense* Cushman, × 68
Sakamachi R–2 well, Ushigakubi formation
Fig. 2. *Nonionella miocencia stella* Cushman and Moyer, × 100
Sakamachi R–2 well, Ushigakubi formation
Fig. 3. *Nonionella higashiyamaense* Matsunaga, n. sp., × 100
Nobe River, Kochi-gun, Niigata Prefecture, Higashiyama formation
Fig. 4. *Nonionella* sp., × 104
Kakuda R–1 well, Nishiyama formation
Figs. 5, 6. *Polystomellina discorbinoides* Yabe and Hanzawa, × 53
Kamiyamada, Naigo-mura, Kariwa-gun, Niigata Prefecture, Haizume formation
Fig. 7. *Pseudononion japonicum* Asano, × 92
Sakamachi R–3 well, Ushigakubi formation
Fig. 8. *Pseudononion kanbaraense* Matsunaga, n. sp., × 120
Matsunaga R–1 well, Haizume formation

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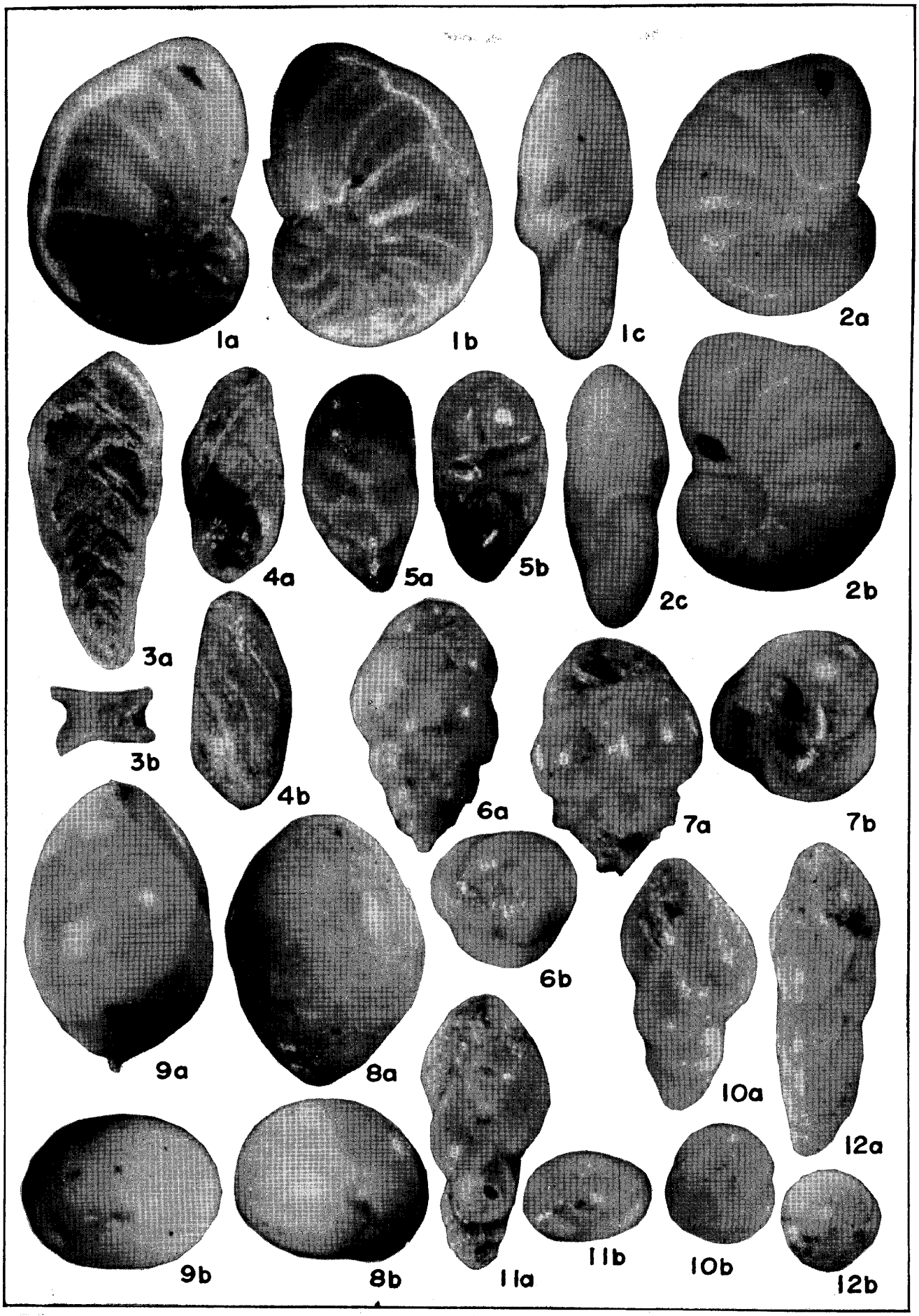



T. Matsunaga Photo.

Plate 39. **Nonionidae, Buliminidae**

Fig. 1. *Pseudononion oinomikadoi* Matsunaga, n. sp., × 103
Suibara R–3 well, Ushigakubi formation
Fig. 2. *Pseudononion tredecum* Asano, × 100
Suibara R–3 well, Ushigakubi formation
Fig. 3. *Bolivinita quadrilatera* (Schwager), × 120
Sakamachi R–2 well, Ushigakubi formation
Fig. 4. *Buliminella elegantissima* (d'Orbigny), × 134
Iwata R–1 well, Shiiya formation.
Fig. 5. *Robertina hanzawai* (Asano), × 123
Daidokaji R–17 well, Ushigakubi formation
Fig. 6. *Bulimina acanthia* Costa, × 121
Suibara R–3 well, Ushigakubi formation
Fig. 7. *Bulimina aculeata* d'Orbigny, × 112
Daidokaji R–17 well, Ushigakubi formation
Fukuura R–1 well, Funakawa formation
Fukuura R–1 well, Funakawa formation
Fig. 9. *Bulimina* (*Desinobulimina*) *auriculata* Bailey, × 82
Warimachi, Niitsu City, Niigata Prefecture, Koguchi formation
Fig. 10, 11. *Bulimina elongata tenera* Reuss, × 120
Shimada-mura, Santo-gun, Niigata Prefecture, Haizume formation
Fig. 12. *Bulimina exilis tenuata* (Cushman), × 113
Suibara R–3 well, Ushigakbui formation

Plate 40. **Buliminidae**

Fig. 1. *Bulimina* cf. *inflata* Seguenza, × 72
Fukuura R–1 well, Funakawa formation

Fig. 2. *Bulimina kamedaensis* Matsunaga, n. sp., × 49
Kameda R–1 well, Onnagawa formation

Fig. 3. *Bulimina marginata* d'Orbigny, × 122
Fukuura R–1 well, Sasaoka formation

Fig. 4. *Bulimina pupoides* d'Orbigny, × 43
Shibata R–1 well, Shiroiwa formation

Fig. 5. *Bulimina* cf. *simplex* Terquem, × 106
Osawa, Okanbara-mura, Nakakanbara-gun, Niigata Prefecture, Koguchi formation

Fig. 6. *Bulimina striata* d'Orbigny, × 60
Kakuda R–1 well, Nishiyama formation

Fig. 7. *Globobulimina perversa* (Cushman), × 47
Nagasawa-mura, Mogami-gun, Yamagata Prefecture, Kusanagi formation

Fig. 8. *Bifarina* cf. *tombigbeensis* Hadley, × 77
Shibata R–12 well, Ushigakubi formation

Figs. 9, 10. *Bolivina cochei* Cushman and Adams, × 105
Kitaimogawa, Morimachi-mura, Minamikanbara-gun, Niigata Prefecture, Nanatani formation

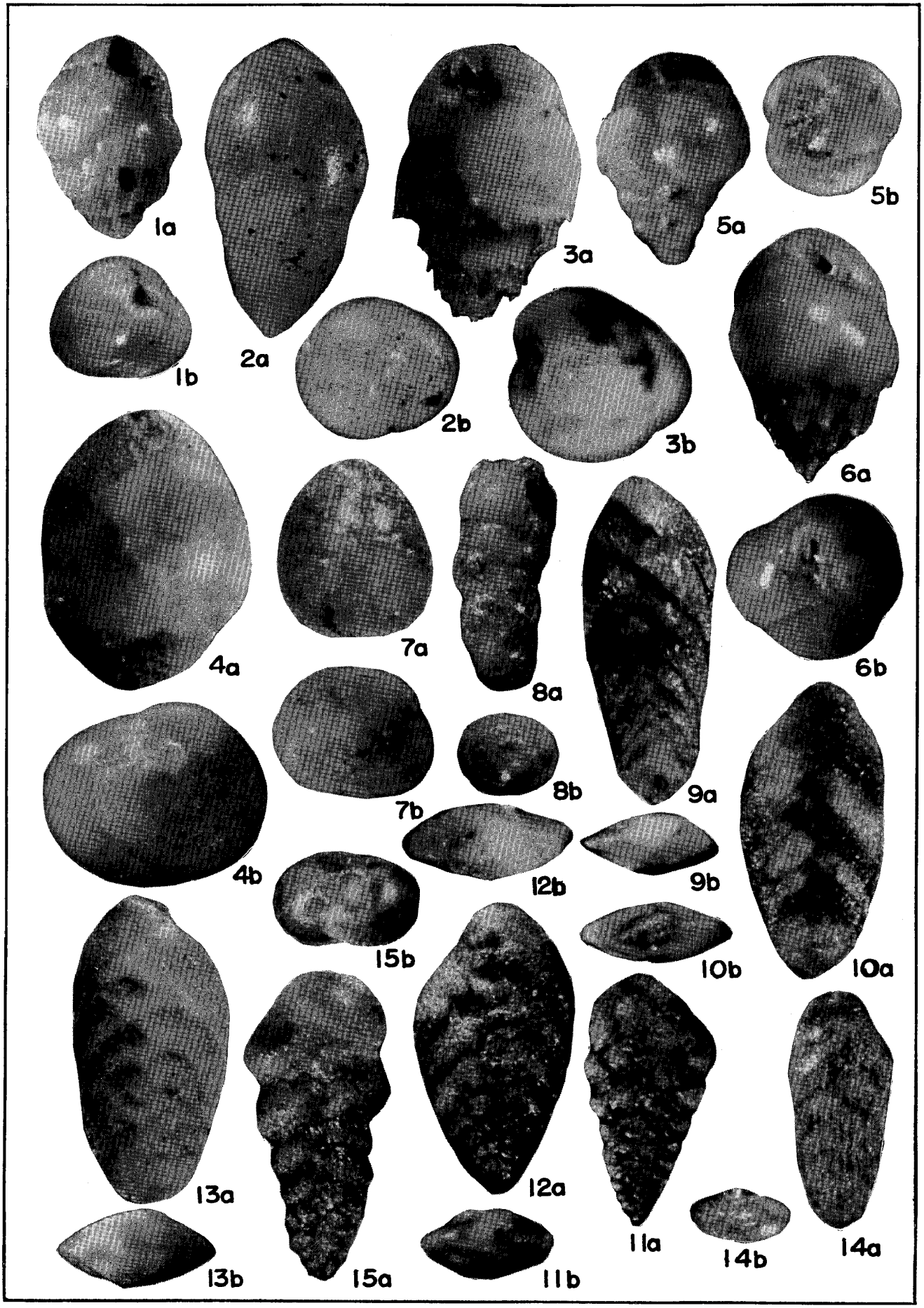
Fig. 11. *Bolivina decussata* H.B. Brady, × 121
Sakamachi R–2 well, Ushigakubi formation

Fig. 12. *Bolivina robusta* H.B. Brady, × 120
Oshima-mura, Higashikubiki-gun, Niigata Prefecture, Shiroiwa formation

Fig. 13. *Bolivina argentea* Cushman, × 92
South coast of the Oga Peninsula, Wakimoto-mura, Minamiakita-gun, Akita Prefecture, Sasaoka formation

Fig. 14. *Bolivina striatula nishikanbaraensis* Matsunaga, n. subsp., × 99
Sone R–1 well, Uonuma group

Fig. 15. *Bolivina subspinescens* Cushman, × 89
Yahiko R–1 well, Shiiya formation

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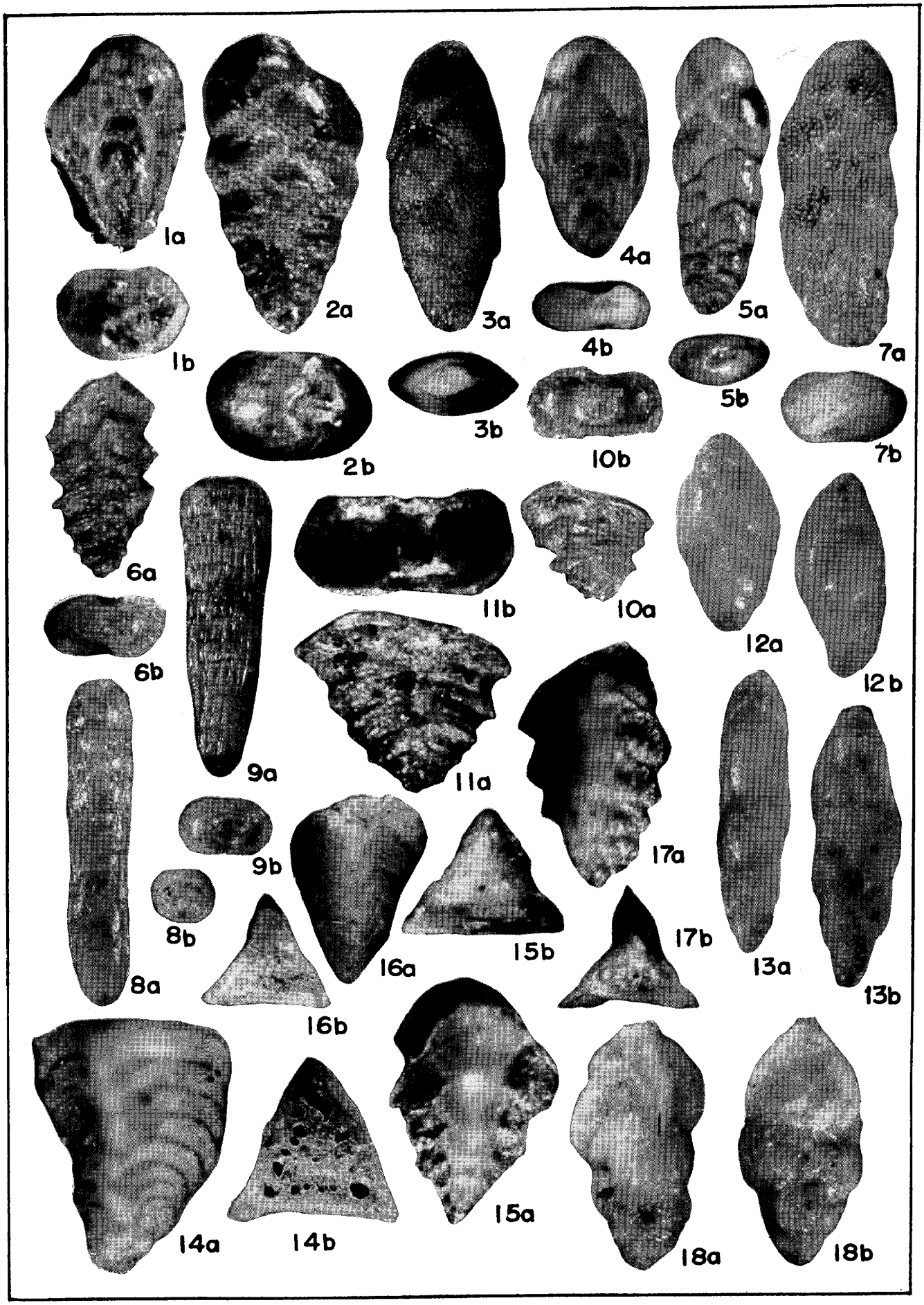



T. Matsunaga Photo.

Plate 41. **Buliminidae**

Fig. 1. *Bolivina subangularis* H.B. Brady, × 75
Osawa, Okanbara-mura, Nakakanbara-gun, Niigata Prefecture, Ushigakubi formation

Fig. 2. *Bolivina zanzibarica* Cushman, × 115
Yahiko R–1 well, Shiiya formation

Fig. 3. *Loxostomum bradyi* (Asano), × 112
Ichinoe, Yabukami-mura, Minamiuonuma-gun, Niigata Prefecture, Shiroiwa formation

Fig. 4. *Loxostomum etigoense* Oinomikado, × 54
Hachimori R–43 well, Funakawa formation

Fig. 5. *Loxostomum limbatum* (H.B. Brady), × 99
Anden, Goriai, Oga City, Akita Prefecture, Katanishi formation

Fig. 6. *Loxostomum lobatum* (H.B. Brady), × 99
Yahiko R–1 well, Shiiya formation

Fig. 7. *Loxostomum mayori* (Cushman), × 81
Yahiko R–1 well, Shiiya formation

Fig. 8. *Rectobolivina bifrons* (H.B. Brady), × 81
Yahiko R–1 well, Shiiya formation

Fig. 9. *Rectobolivina bifrons striatula* (Cushman), × 32
Echigokurokawa C–116 well, Shiroiwa formation

Figs. 10, 11. *Suggrunda yahikoensis* Matsunaga, n. sp., × 109
Yahiko R–1 well, Shiiya formation

Fig. 12. *Virgulina bradyi* Cushman, × 85
Kameda R–1 well, Onnagawa formation

Fig. 13. *Virgulina complanata* Egger, × 17
Kitakaji R–1 well, Nanatani formation

Fig. 14. *Chrysalidinella dimorpha* (Brady), × 53
Inagawa, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation

Fig. 15. *Reussella aculeata* Cushman, × 128
Nodaigawa R–1 well, Higashiyama formation

Fig. 16. *Reussella haizumensis* Asano, × 40
Iwata R–1 well, Nishiyama formation

Fig. 17. *Reussuella pacifica* Cushman and McCulloch, × 93
Niigata R–16 well, Yashiroda formation

Fig. 18. *Angulogerina hughesi* (Galloway and Wissler), × 111
Taya, Iwamisannai-mura, Kawabe-gun, Akita Prefecture, Wakimoto formation

Plate 42. **Buliminidae**

Fig. 1. *Angulogerina kawabeensis* Matsunaga, n. sp., × 97
Iwamisannai-mura, Kawabe-gun, Akita Prefecture, Wakimoto formation

Fig. 2. *Angulogerina kokozuraensis* Asano, × 101
Aizawa, Matsudai-mura, Higashikubiki-gun, Niigata Prefecture, Nunagawa mudstone

Fig. 3. *Hopkinsina imogawaensis* Matsunaga, n. sp., × 57
Kitaimogawa, Morimachi-mura, Minamikanbara-gun, Niigata Prefecture, Nanatani formation

Fig. 4. *Hopkinsina morimachiensis* Matsunaga, n. sp., × 68
Kitaimogawa, Morimachi-mura, Minamikanbara-gun, Niigata Prefecture, Nanatani formation

Fig. 5. *Hopkinsina morimachiensis umedaensis*, Matsunaga, n. subsp., × 64
Umeda R–2 well, Shiiya formation

Fig. 6. *Hopkinsina nanataniensis* Matsunaga, n. sp., × 63
Kitakaji R–2 well, Nanatani formation

Fig. 7. *Hopkinsina sinboi* Matsunaga, n. sp., × 78
Kitakaji R–2 well, Nanatani formation

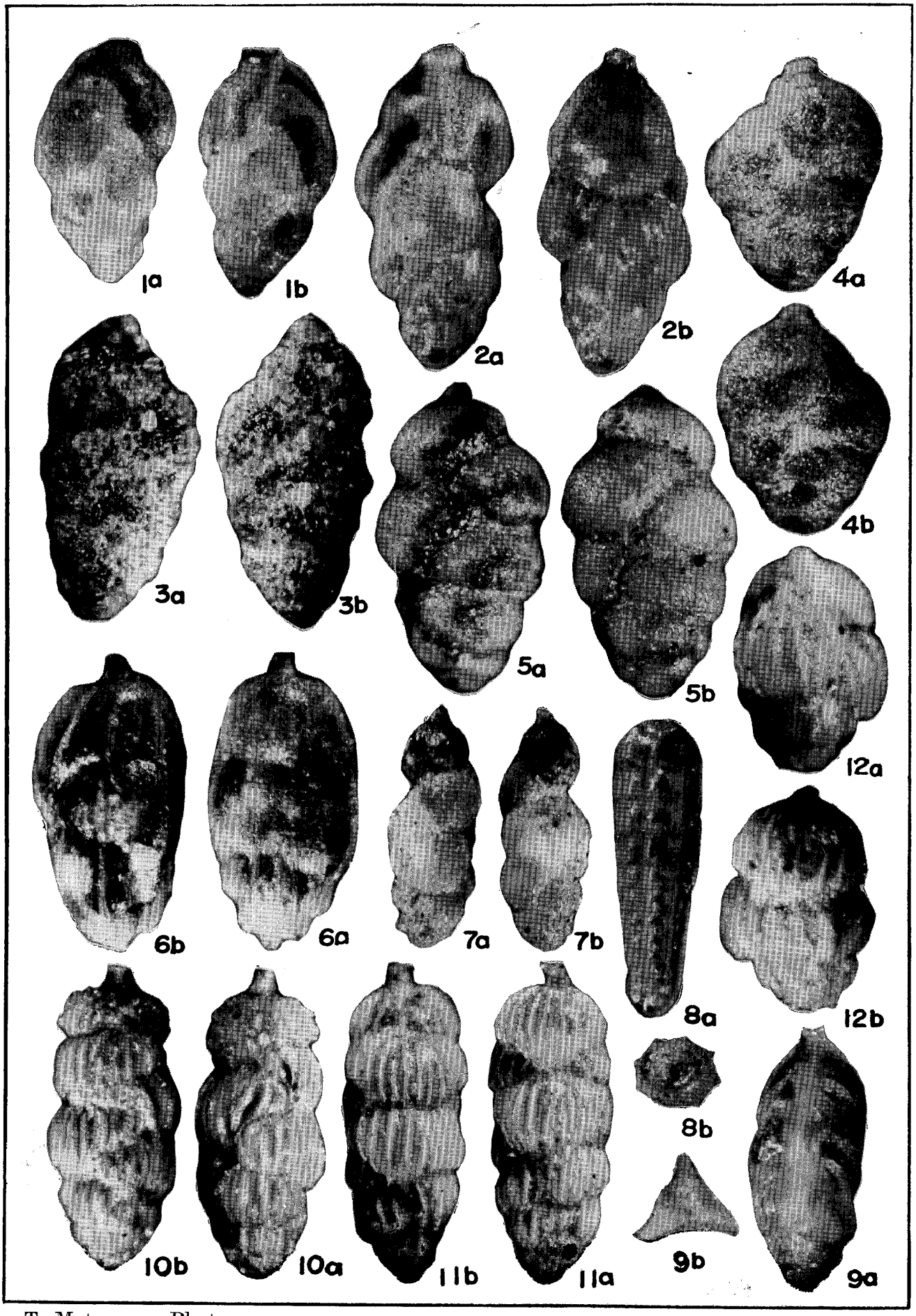
Fig. 8. *Siphogenerina raphanus* (Parker and Jones), × 54
Kamo R–2 well, Ushigakubi formation

Fig. 9. *Trifarina bradyi* Cushman, × 96
Yahiko R–1 well, Shiiya formation

Fig. 10. *Uvigerina asanoi* Matsunaga, n. sp., × 60
Yoita-machi, Santo-gun, Niigata Prefecture, Nishiyama formation

Fig. 11. *Uvigerina excellens* Todd, × 69
Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation

Fig. 12. *Uvigerina nitidula* Schwager, × 96
Naigo-mura, Kariwa-gun, Niigata Prefecture, Natsukawa formation

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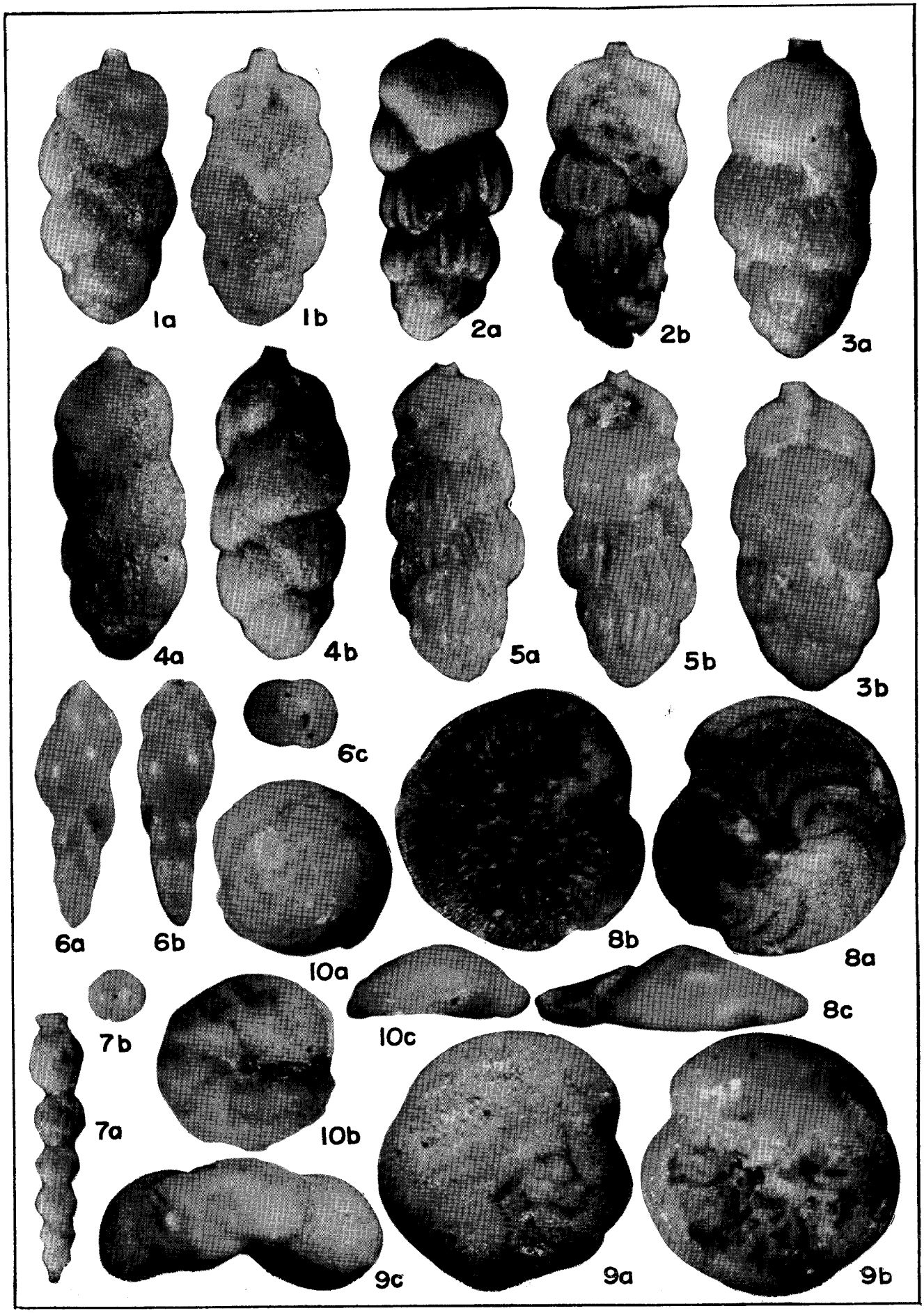


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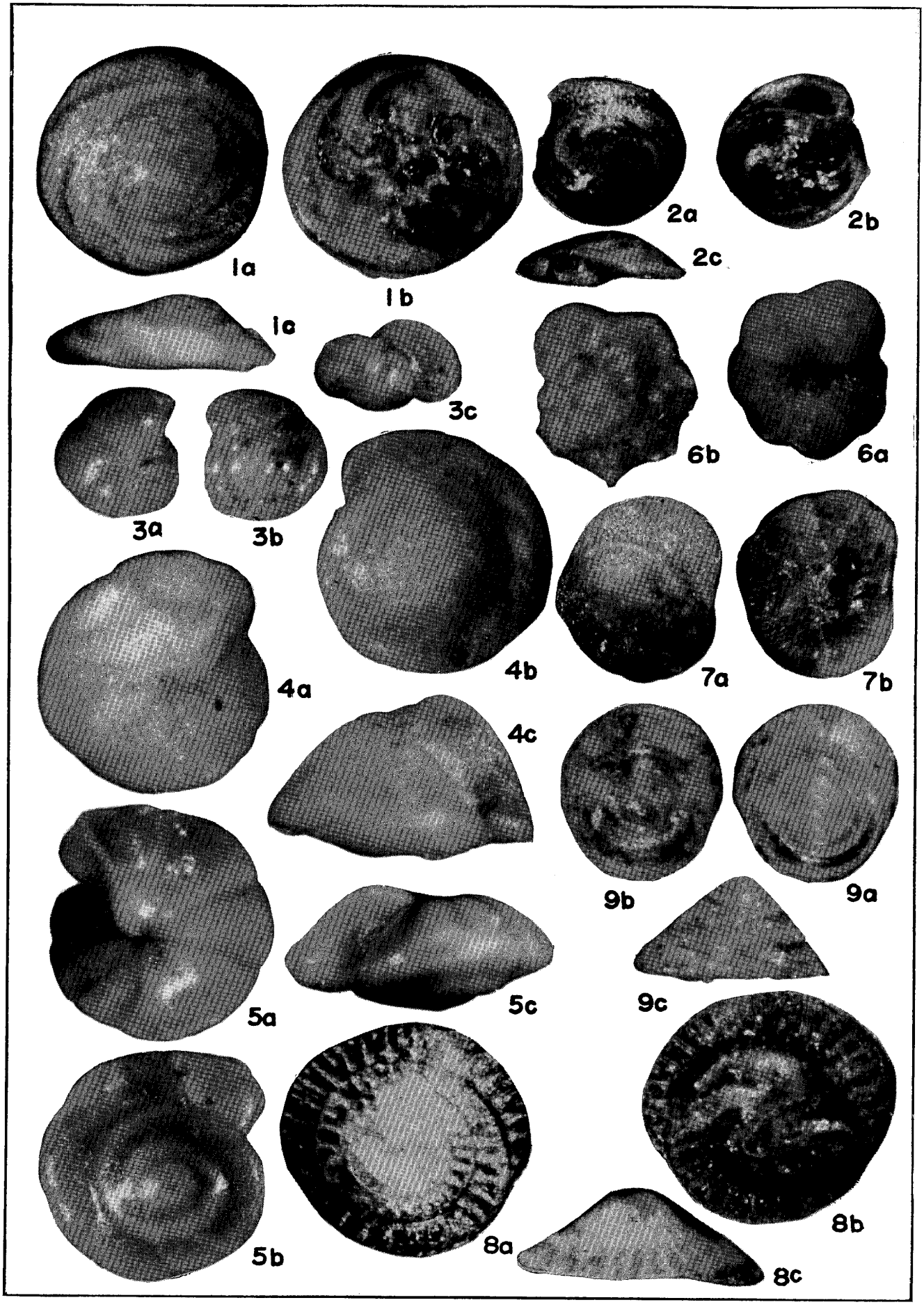
Plate 43. **Buliminidae, Ellipsoidinidae, Rotaliidae**

Fig. 1. *Uvigerina proboscidea* Schwager, × 74
Betsuyama R–53 well, Shiiya formation
Fig. 2. *Uvigerina subperegrina* Cushman and Kleinpell, × 72
Nodaigawa R–2 well, Ushigakubi formation
Fig. 3. *Uvigerina* cf. *urnula* d'Orbigny, × 80
Naigo-mura, Kariwa-gun, Niigata Prefecture, Haizume formation
Fig. 4. *Uvigerina urnula shiiyaensis* Matsunaga, n. subsp., × 77
Umeda R–1 well, Shiiya formation
Fig. 5. *Uvigerina yabei* Asano, × 68
Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation
Fig. 6. *Pleurostomella alternans* Schwager, × 42
Kitakaji R–1 well, Nanatani formation
Fig. 7. *Ellipsonodosaria hyugaensis* Ishizaki, × 100
Kurokawa R–18 well, Higashiyama formation
Fig. 8. *Discorbis subopercularis* Asano, × 67
Betsuyama R–58 well, Haizume formation
Fig. 9. *Discopulvinulina bradyi* (Cushman), × 82
Aida, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation
Fig. 10. *Discopulvinulina* cf. *nitida* (Williamson), × 85
Funabashi, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation

Plate 44. **Rotaliidae**

Fig. 1. *Discopulvinulina orbicularis* (Terquem), × 78
Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation
Fig. 2. *Discopulvinulina stachi* Asano, × 61
Kamo R–2 well, Ushigakubi formation
Fig. 3. *Gyroidina nipponica* Ishizaki, × 79
Sakamachi R–2 well, Ushigakubi formation
Fig. 4. *Gyroidina orbicularis* d'Orbigny, × 87
Kitakaji R–1 well, Nanatani formation
Fig. 5. *Gyroidina* cf. *soldanii* d'Orbigny, × 70
Tanaka R–1 well, Nishiyama formation
Fig. 6. *Heronallenia oinomikadoi* Matsunaga, n. sp., × 79
Funakawa-machi, Minamiakita-gun, Akita Prefecture, Wakimoto formation
Fig. 7. *Heronallenia stellata* Takayanagi, × 67
Mikozawa, Kamijo-mura, Kariwa-gun, Niigata Prefecture, Haizume formation
Fig. 8. *Patellina* cf. *corrugata* Williamson, × 119
Wakimoto-mura, Minamiakita-gun, Akita Prefecture, Wakimoto formation
Fig. 9. *Patellinella hanzawai* Asano, × 104
Shimada-mura, Santo-gun, Niigata Prefecture, Haizume formation

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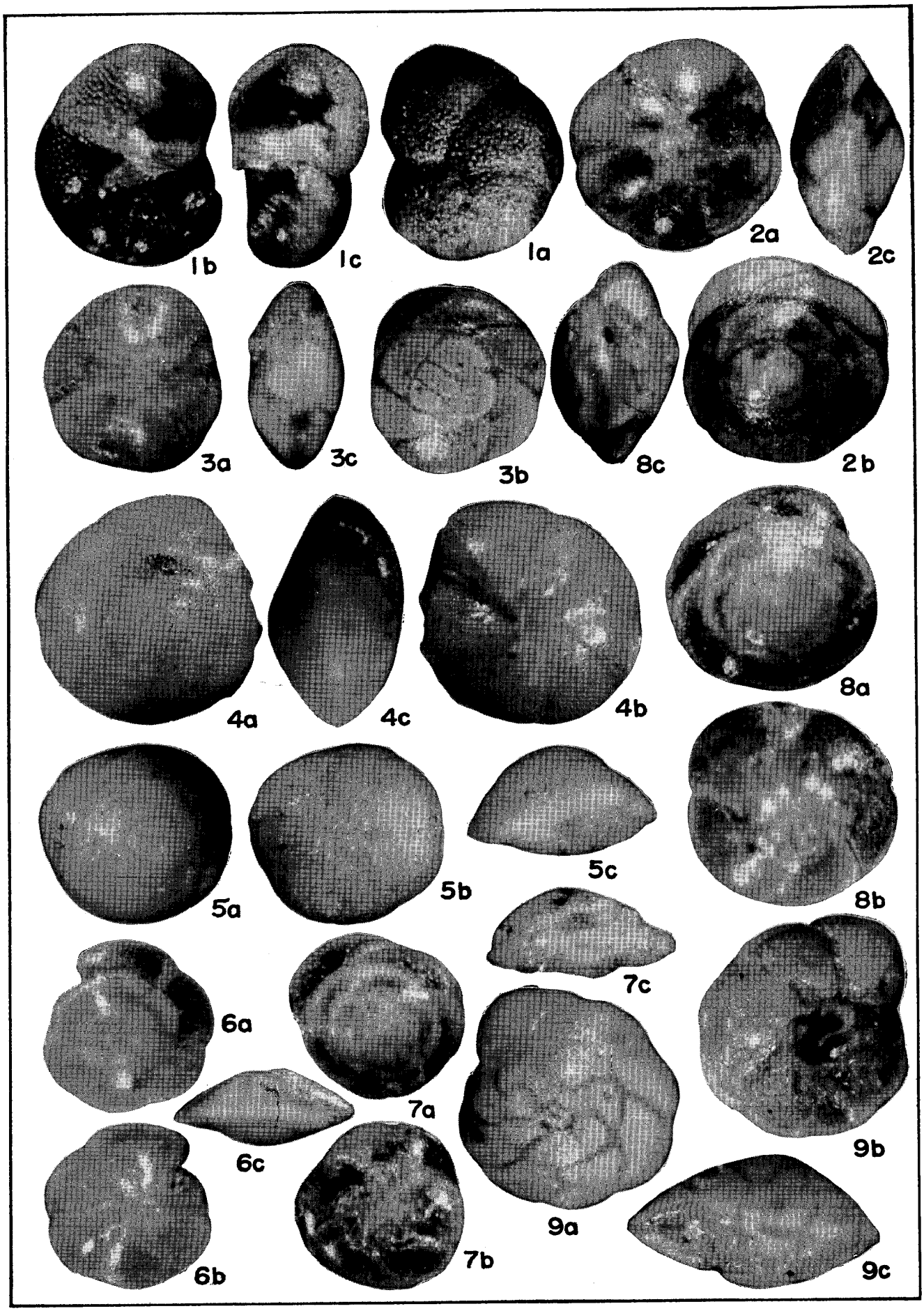


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Plate 45. **Rotaliidae**

Fig. 1. *Valvulineria sadonica* Asano, × 92
Kakuda R–Z well, Haizume formation
Fig. 2. *Buccella inusitata* Andersen, × 71
Kamo R–2 well, Ushigakubi formation
Fig. 3. *Buccella frigida* (Cushman), × 76
Matsunaga R–1 well, Haizume formation
Fig. 4. *Eponides haidingerii* (d'Orbigny), × 36
Yahiko R–2 well, Shiiya formation
Fig. 5. *Eponides nipponicus* (Husezima and Maruhasi), × 67
Ogi, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation
Fig. 6. *Eponides umbonatus* (Reuss). × 82
Yoita-machi, Santo-gun, Niigata Prefecture, Nishiyama formation
Fig. 7. *Pseudoeponides japonica* Uchio, × 100
Sakamachi R–3 well, Ushigakubi formation
Fig. 8. *Pseudoeponides nakazatoensis* (Kuwano), × 109
Kamo R–2 well, Ushigakubi formation
Fig. 9. *Rotalia nipponica* Asano, × 70
Anden, Goriai-mura, Minamiakita-gun, Akita Prefecture, Katanishi formation

Plate 46. **Rotaliidae**

Fig. 1. *Rotalia* cf. *beccarii* (Linnaeus), × 80
Kaki, Yamadori-mura, Koshi-gun, Niigata Prefecture, Shiroiwa formation

Fig. 2. *Rotalia inflata* (Seguenza), × 66
Tamugeyama-mura, Kitauonuma-gun, Niigata Prefecture, Shiroiwa formation

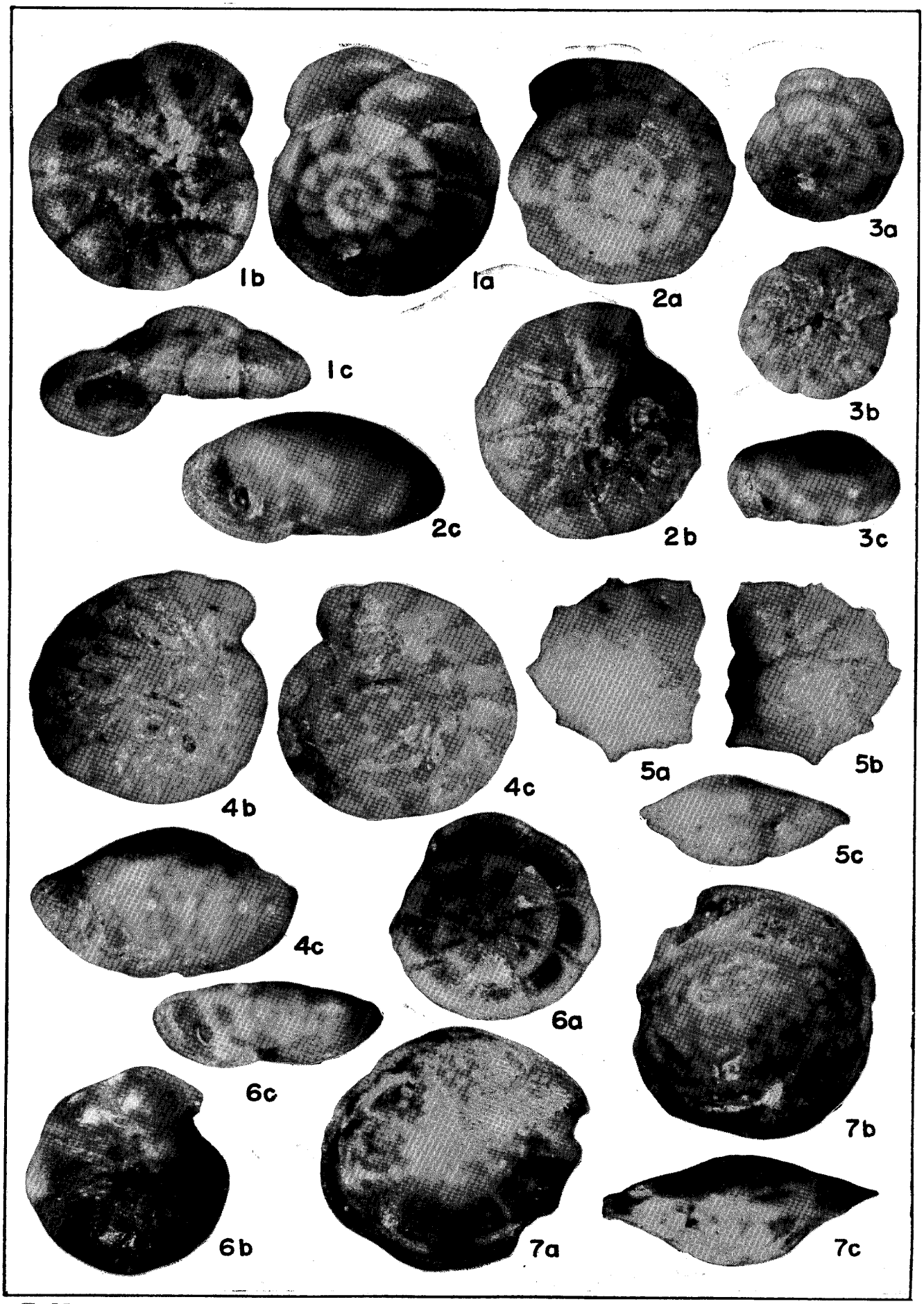
Fig. 3. *Rotalia japonica* Hada, × 37
Hanyuda R–1 well, Ushigakubi formation

Fig. 4. *Rotalia ketienziensis* (Ishizaki), × 36
Shibata R–6 well, Ushigakubi formation

Fig. 5. *Rotalia ozawai* Asano, × 79
Kurokawa R–18 well, Higashiyama formation

Fig. 6. *Rotalia takanabensis* (Ishizaki), × 63
Funagoshi R–1 well, Tofuiwa formation

Fig. 7. *Höglundina asanoi* Matsunaga, n. sp., × 47
Inagawa, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation

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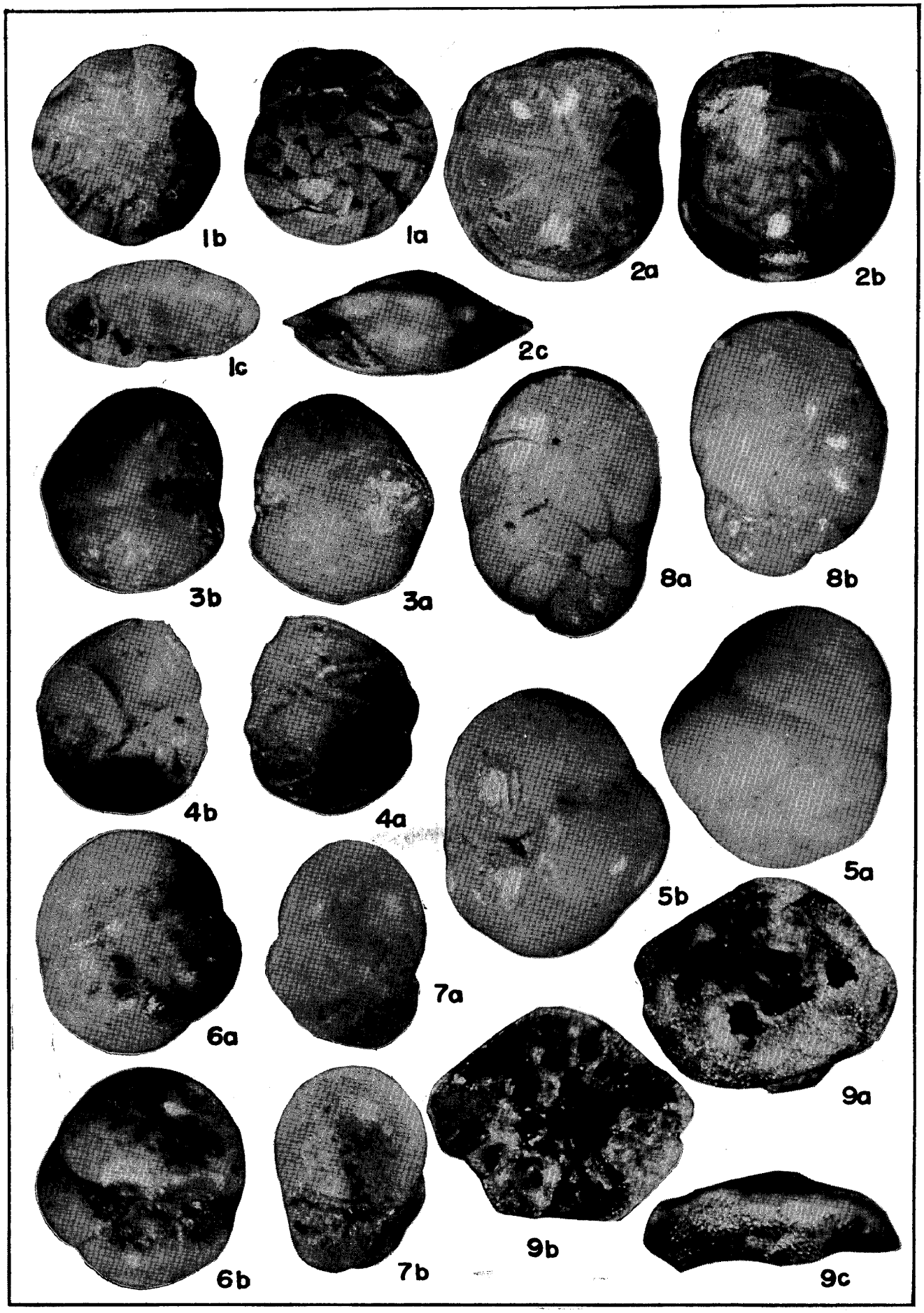


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Plate 47. **Rotaliidae, Cymbaloporidae**

Fig. 1. *Rotalia* cf. *papillosa* Brady, × 37
Kamo City, Niigata Prefecture, Haizume formation
Fig. 2. *Höglundina elegans* (d'Orbigny), × 38
Yahiko R–2 well, Shiiya formation
Fig. 3. *Poroeponides cribrorepandus* Asano and Uchio, × 47
Murata, Shimada-mura, Santo-gun, Niigata Prefecture, Haizume formation
Fig. 4. *Poroepondies cribroconcameratus* Asano and Uchio, × 45
Inagawa, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation
Fig. 5. *Baggina philippinensis* (Cushman), × 42
Ikeura, Naigo-mura, Kariwa-gun, Niigata Prefecture, Haizume formation
Fig. 6. *Baggina philippinensis pilulifera* Cushman and Todd, × 92
Hashida-mura, Nakakanbara-gun, Niigata Prefecture, Haizume formation
Fig. 7. *Baggina totomiensis* Makiyama, × 57
Nodaigawa R–1 well, Ushigakubi formation
Fig. 8. *Cancris auriculus* (Fichtel and Moll), × 80
Ogi, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation
Fig. 9. *Cymbaloporetta poeyi* (d'Orbigny), × 75
Kamijo-mura, Kariwa-gun, Niigata Prefecture, Haizume formation

Plate 48. **Cassidulinidae**

Fig. 1. *Epistominella pulchella* Husezima and Maruhasi, × 101
Sakamachi R–2 well, Ushigakubi formation

Fig. 2. *Epistominella tamana* (Kuwano), × 134
Yahiko R–2 well, Shiiya formation

Fig. 3. *Cassidulina asanoi* Uchio, × 117
Teradomari R–1 well, Nanatani formation

Fig. 4. *Cassidulina japonica* Asano and Nakamura, × 34
Koguchi, Niitsu City, Niigata Prefecture, Koguchi formation

Fig. 5. *Cassidulina kasiwazakiensis* Husezima and Maruhasi, × 90
Makihara, Otsu-mura, Santo-gun, Niigata Prefecture, Nishiyama formation

Fig. 6. *Cassidulina laevigata* d'Orbigny, × 103
Inagawa, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation

Fig. 7. *Cassidulina orientale* Cushman × 87
Asahi R–30 well, Ushigakubi formation

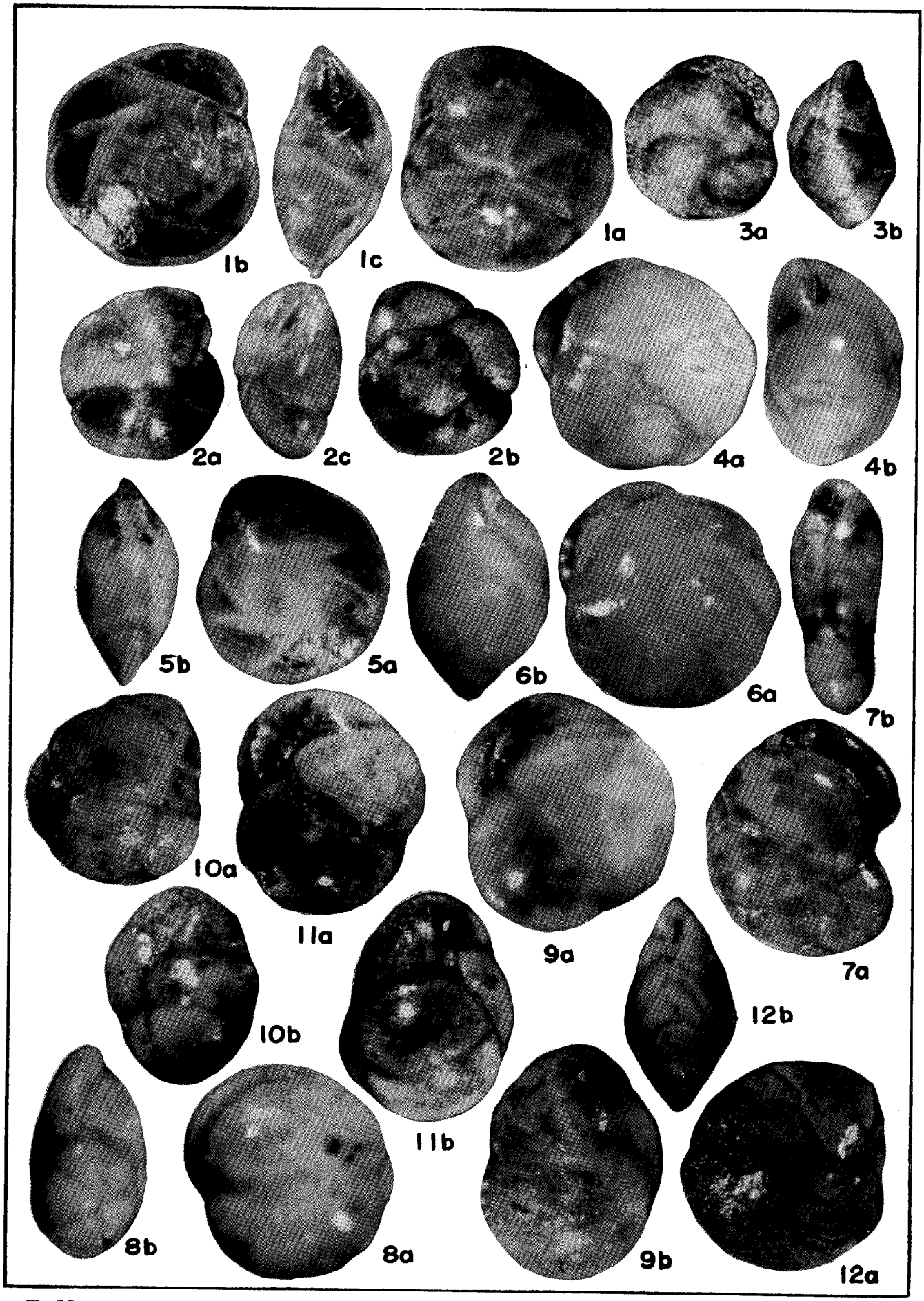
Fig. 8. *Cassidulina sagamiensis* Asano and Nakamura, × 91
Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation

Fig. 9. *Cassidulina subglobosa* Brady, × 74
Kamo R–2 well, Nishiyama formation

Fig. 10. *Cassidulina subglobosa parva* Asano and Nakamura, × 118
Nodaigawa R–1 well, Ushigakubi formation

Fig. 11. *Cassidulina sublgobosa parva* Asano and Nakamura, × 72
Omo R–106 well, Ushigakubi formation

Fig. 12. *Cassidulina sublimbata* Asano and Nakamura, × 38
Inagawa, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation

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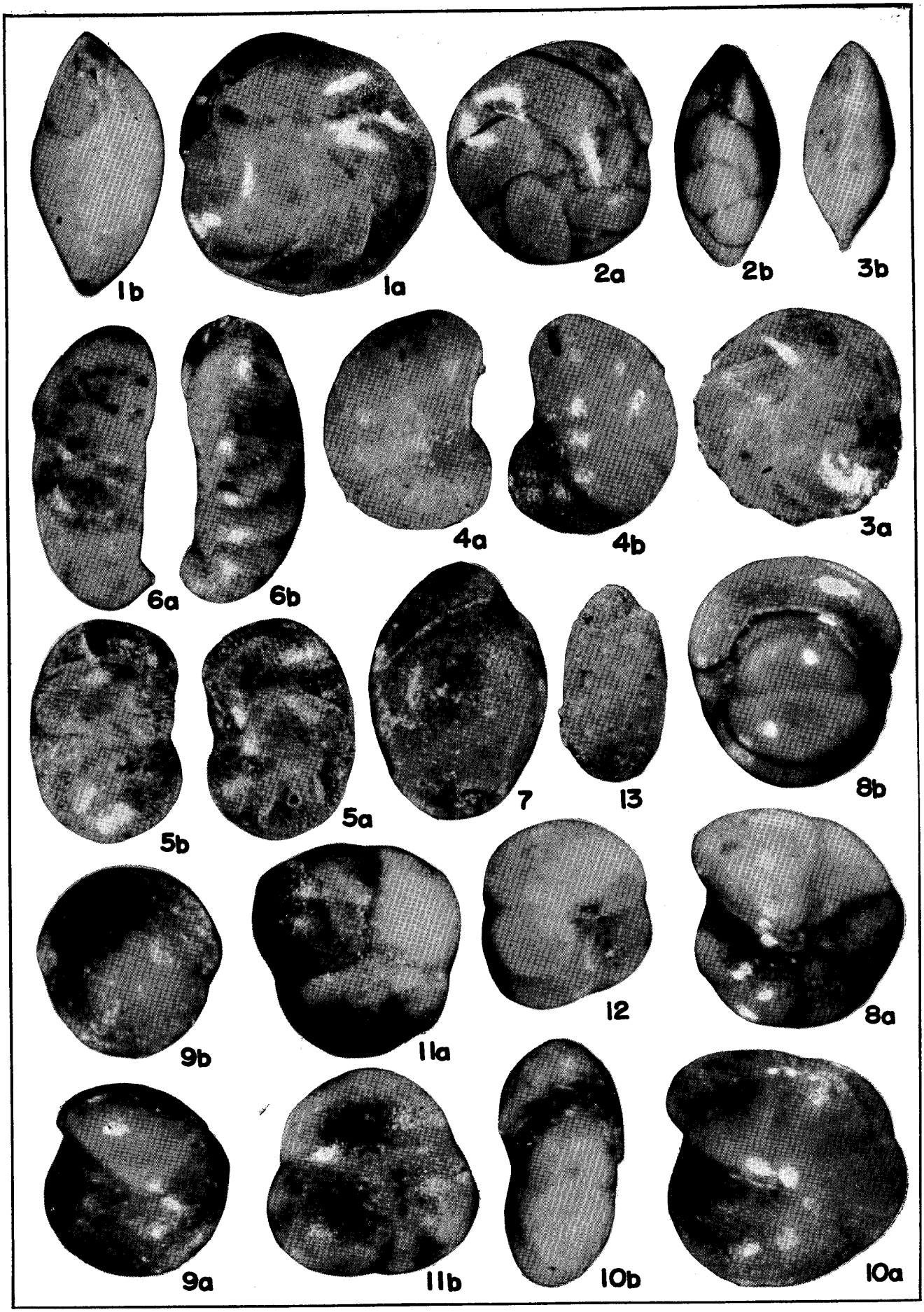


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Plate 49. **Cassidulinidae, Chilostomellidae**

Figs. 1, 2. *Cassidulina yabei* Asano and Nakamura, Fig. 1, × 58; Fig. 2, × 59
Anden, Kitaura-machi, Oga City, Wakimoto formation and Yahiko R–1 well, Shiiya formation

Fig. 3. *Cassidulina yabei serrata* Matsunaga, n. subsp., × 70
Kusozu, Niitsu City, Niigata Prefecture, Ushigakubi formation

Fig. 4. *Cassidulinoides compacta* Cushman and Ellisor, × 111
Sakamachi R–3 well, Nishiyama formation

Fig. 5. *Cassidulinoides sasaokaensis* Matsunaga, n. sp., × 112
Sasaoka-mura, Kitakanbara-gun, Niigata Prefecture, Ushigakubi formation

Fig. 6. *Cassidulinoides tenuis* Phleger and Parker, × 98
Higashihirata-mura, Akumi-gun, Yamagata Prefecture, Maruyama formation

Fig. 7. *Chilostomella mediterranensis* Cushman and Todd, × 33
Betsuyama R–66 well, Teradomari formation

Fig. 8. *Pullenia apertula* Cushman, × 120
Yoita-machi, Santo-gun, Niigata Prefecture, Nishiyama formation

Fig. 9. *Pullenia bulloides* (d'Orbigny), × 127
Kakuda R–1 well, Shiiya formation

Fig. 10. *Pullenia salisburyi* P.E. and K.C. Stewart, × 127
Nagasawa, Funagata-mura, Mogami-gun, Yamagata Prefecture, Kusanagi formation

Fig. 11. *Sphaeroidina austriaca* d'Orbigny, × 103
Fukuura R–1 well, Tentokuji formation

Fig. 12. *Sphaeroidina* cf. *compacta* Cushman and Todd, × 110
Shibata R–15 well, Ushigakubi formation

Fig. 13. *Chilostomella oolina* Schwager, × 25
Shibata R–12 well, Ushigakubi formation

Plate 50. **Anomalinidae**

Fig. 1. *Anomalina glabrata* Cushman, × 140
Nagano, Funagata-mura, Mogami-gun, Yamagata Prefecture, Kusanagi formation

Fig. 2. *Anomalinoides* cf. *nobilis* Brotzen, × 72
Umeda R–1 well, Nishiyama formation

Fig. 3. *Echigoina furutsuensis* Matsunaga, n. sp., × 123
Furutsu R–1 well, Ushigakubi formation

Fig. 4. *Echigoina hataii* Matsunaga, n. sp., × 85
Hashida, Niitsu City, Niigata Prefecture, Koguchi formation

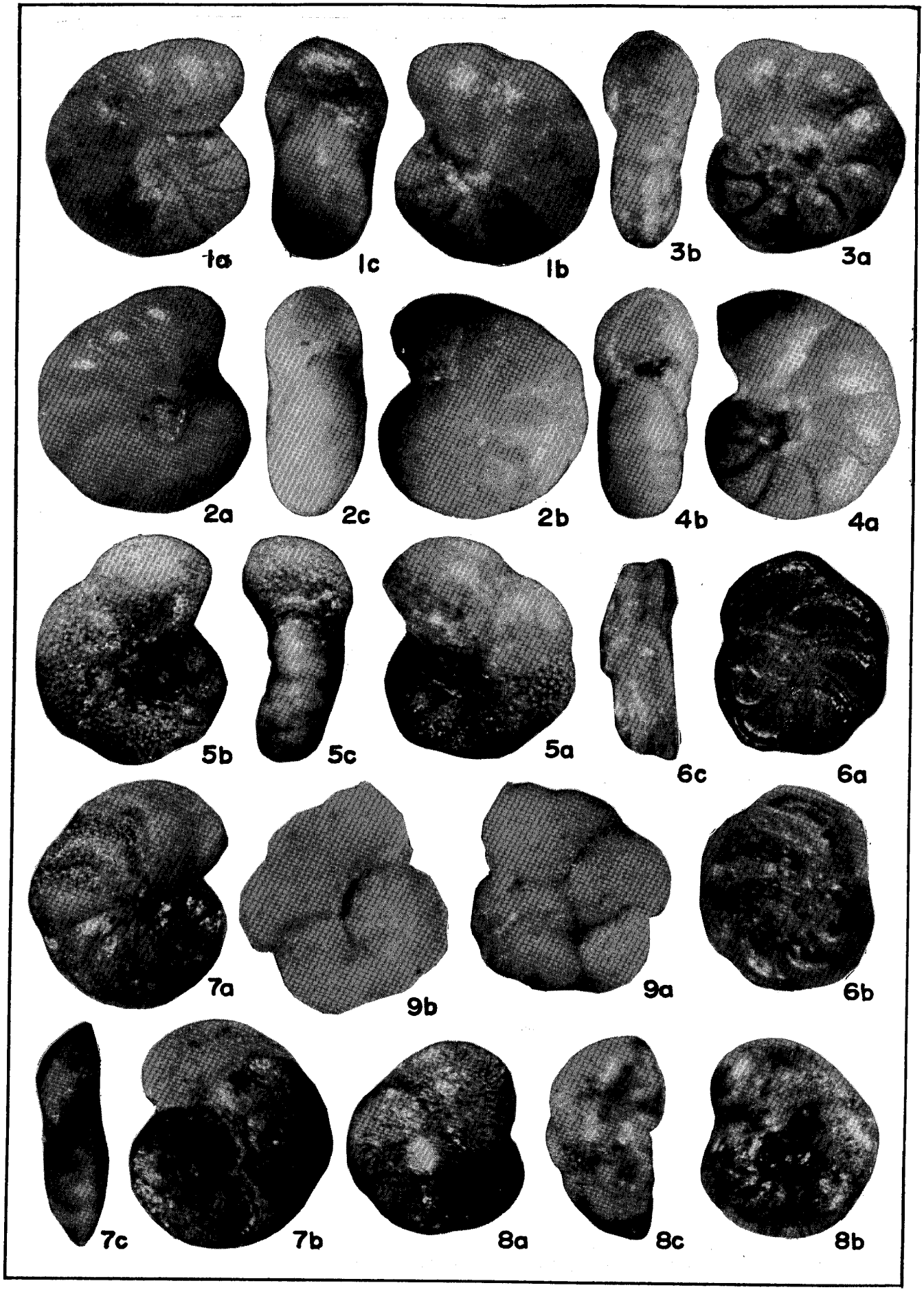
Fig. 5. *Oinomikadoina ogiensis* Matsunaga, × 47
Funabashi, Nishigoshi-mura, Kariwa-gun, Niigata Prefecture, Haizume formation

Fig. 6. *Planulina granotruncana* Matsunaga, n. sp., × 94
Yoita-machi, Santo-gun, Niigata Prefecture, Nishiyama formation

Fig. 7. *Planulina wuellerstorfi* (Schwager), × 57
Niitsu hot spring well, Niitsu City, Niigata Prefecture, Ushigakubi formation ?

Fig. 8. *Buningia creeki* Finlay, × 90
Yahiko R–2 well, Shiiya formation

Fig. 9. *Cibicidella variabilis* (d'Orbigny), × 41
Funabashi, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation




T. Matsunaga Photo.

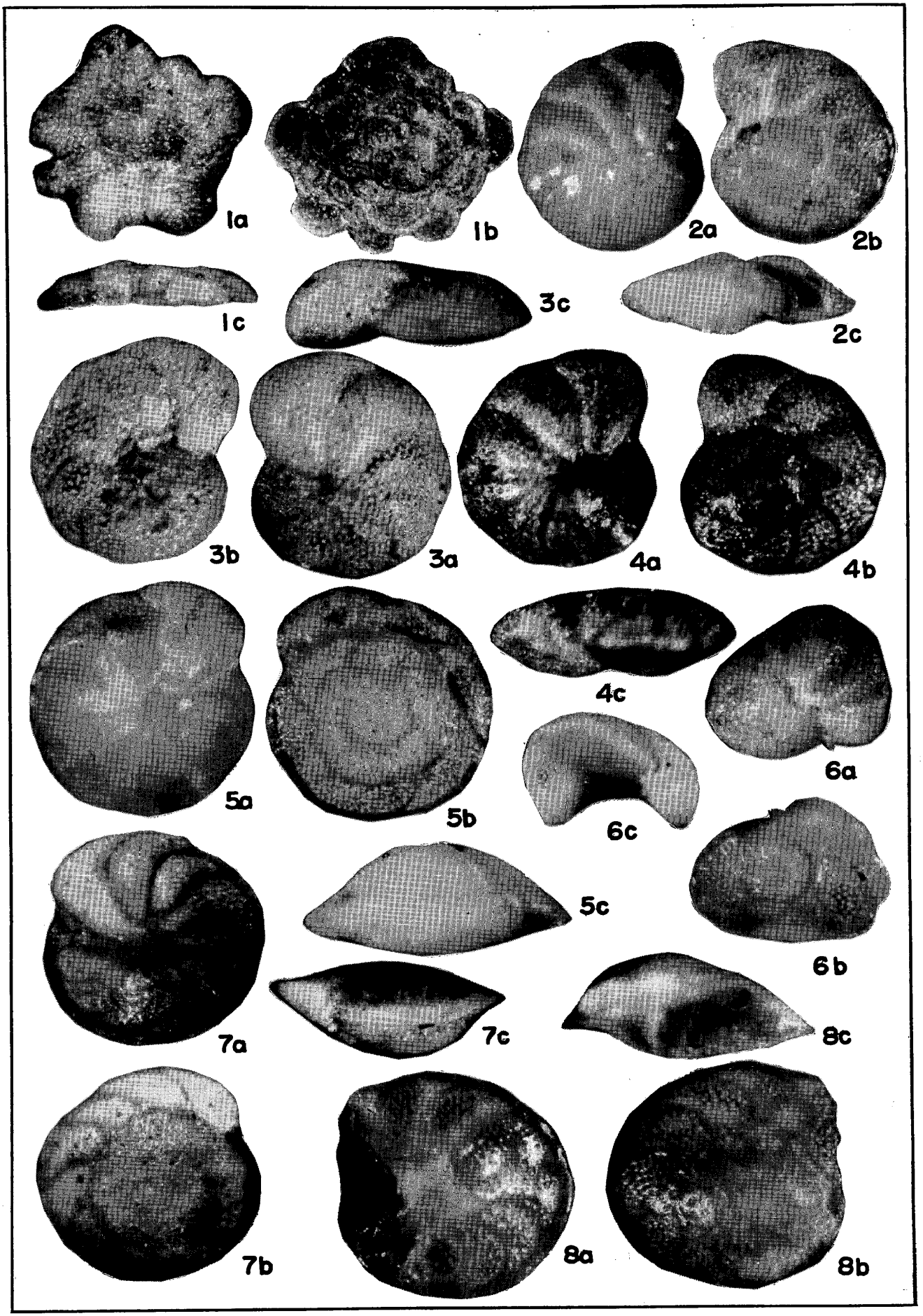



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Plate 51. **Anomalinidae**

Fig. 1. *Cibicidella variabilis* (d'Orbigny), × 43
Funabashi, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation

Fig. 2. *Cibicides* aff. *aknerianus* (d'Orbigny), × 70
Umeda R–1 well, Nishiyama formation

Fig. 3. *Cibicides aknerianus* (d'Orbigny), 62
Sakamachi R–2 well, Ushigakubi formation

Fig. 4. *Cibicides asanoi* Matsunaga, n. sp., × 83
Sakamachi R–2 well, Ushigakubi formation

Fig. 5. *Cibicides inagawaensis* Matsunaga, n. sp., × 77
Inagawa, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation

Fig. 6. *Cibicides lobatulus* (Walker and Jacob), × 51
Asojima, Ukawa-mura, Kariwa-gun, Niigata Prefecture, Haizume formation

Figs. 7, 8. *Cibicides malloryi* Matsunaga, n. sp., Fig. 7, × 90; Fig. 8, × 79
Sakamachi R–1 well, Nanatani formation

Plate 52. **Anomalinidae, Lituolidae, Rotaliidae**

Fig. 1. *Cibicides* cf. *refulgens* (Montfort), × 62
Kamiyamada, Naigo-mura, Kariwa-gun, Niigata Prefecture, Haizume formation

Fig. 2. *Cibicides tenuimargo* (Brady), × 37
Haizume, Naigo-mura, Kariwa-gun, Niigata Prefecture, Haizume formation

Fig. 3. *Cibicides yoitaensis* Matsunaga, n. sp., × 69
Yoita R–2 well, Nanatani formation

Fig. 4. *Dyocibicides biserialis* Cushman and Valentine, × 43
Inagawa, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation

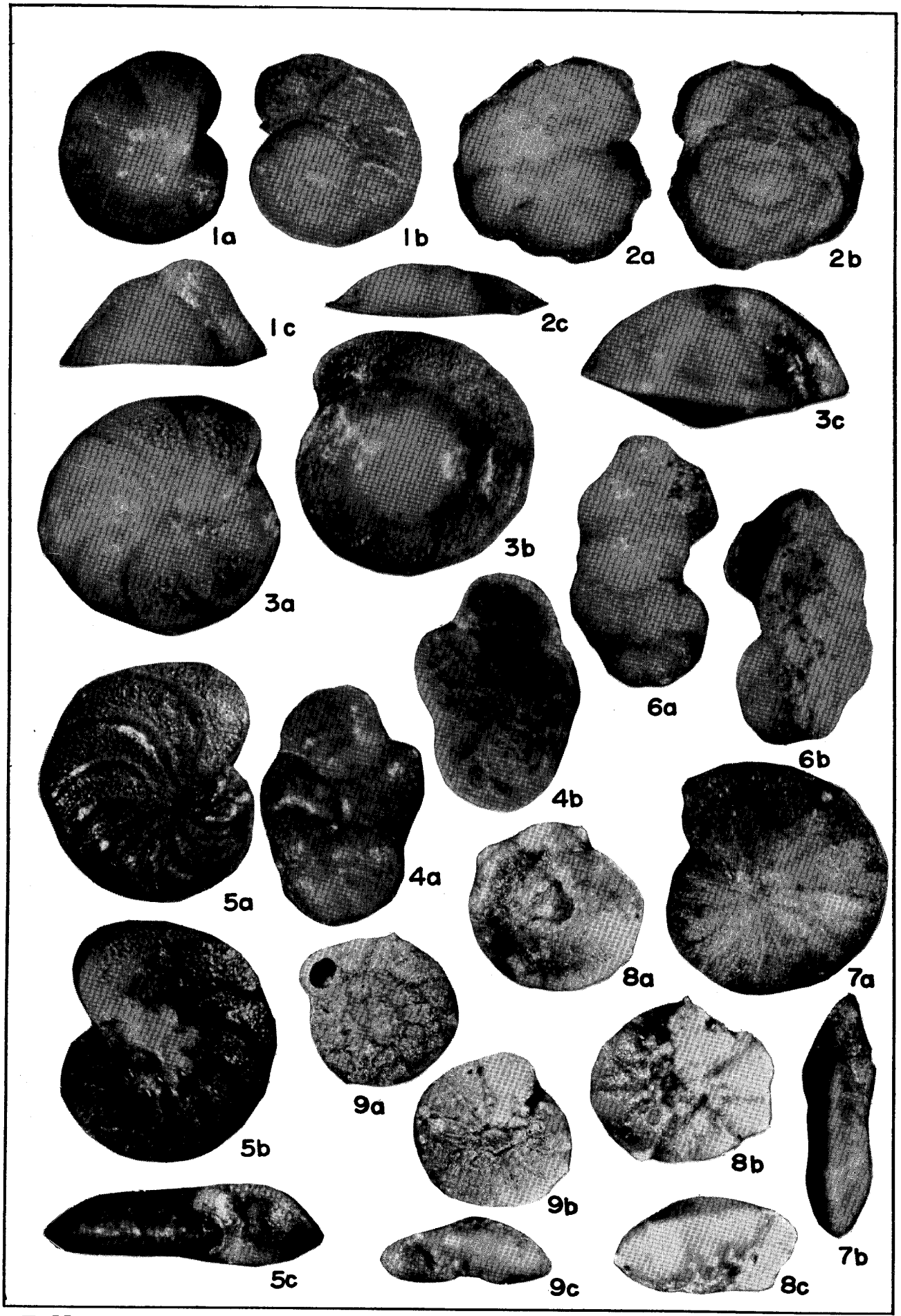
Fig. 5. *Hanzawaia nipponica* Asano, × 82
Nodaigawa R–1 well, Ushigakubi formation

Fig. 6. *Stichocibicides* aff. *aricki* Bermudez, × 58
Inagawa, Nishigoshi-mura, Santo-gun, Niigata Prefecture, Haizume formation

Fig. 7. *Cyclammina japonica* Asano, × 32
Teradomari R–1 well, Nanatani formation

Fig. 8. *Rotalia tanosawaensis* Iwasa and Kikuchi, × 36
Kamiouchi-mura, Yuri-gun, Akita Prefecture, Nishikurosawa formation

Fig. 8. *Rotalia tochigiensis* Uchio, × 32
Kirasawa, Kitaura-machi, Oga City, Akita Prefecture, Nishikurosawa formation

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