

Franco S. Medioli  
David B. Scott

Department of Geology  
Dalhousie University  
Halifax, N. S. Canada

## Emendation of the genus *Discanomalina* Asano and its implications on the taxonomy of some of the attached foraminiferal forms

### ABSTRACT

An array of foraminiferal species and subspecies previously attributed to the genera *Rotalina*, *Anomalina*, *Planorbulina*, *Discorbina*, *Discanomalina* and *Paromalina* can be arranged in an intergradational morphological series. The series is composed of sympatric elements and is continuous, suggesting that this array of taxa represents only one highly variable species of the genus *Discanomalina*, namely *Discanomalina semipunctata* (Bailey). The morphological variations between attached versus nonattached specimens within the same species has been largely ignored in micropaleontology; we use this relatively simple consideration to clarify the taxonomy of *D. semipunctata*, and suggest that it be applied in the study of other groups composed of both attached and nonattached forms.

### INTRODUCTION

In the course of studying a Recent foraminiferal population from the continental shelf off Nova Scotia we surveyed the literature on the related genera *Discanomalina* Asano, 1951 and *Paromalina* Loeblich and Tappan, 1957. The relationship of the two proved to be more complex than we had anticipated. At the end of the survey we concluded that the two genera were either two separate entities represented by many loosely defined species and subspecies, or that there was only one valid genus represented by one unusually variable species.

So that the reader can understand the discussion that follows, a simplified version of the descriptions of these two genera, as they appear in the Treatise on Invertebrate Paleontology (Loeblich and Tappan, 1964, p. C757; p. C763) is presented here:

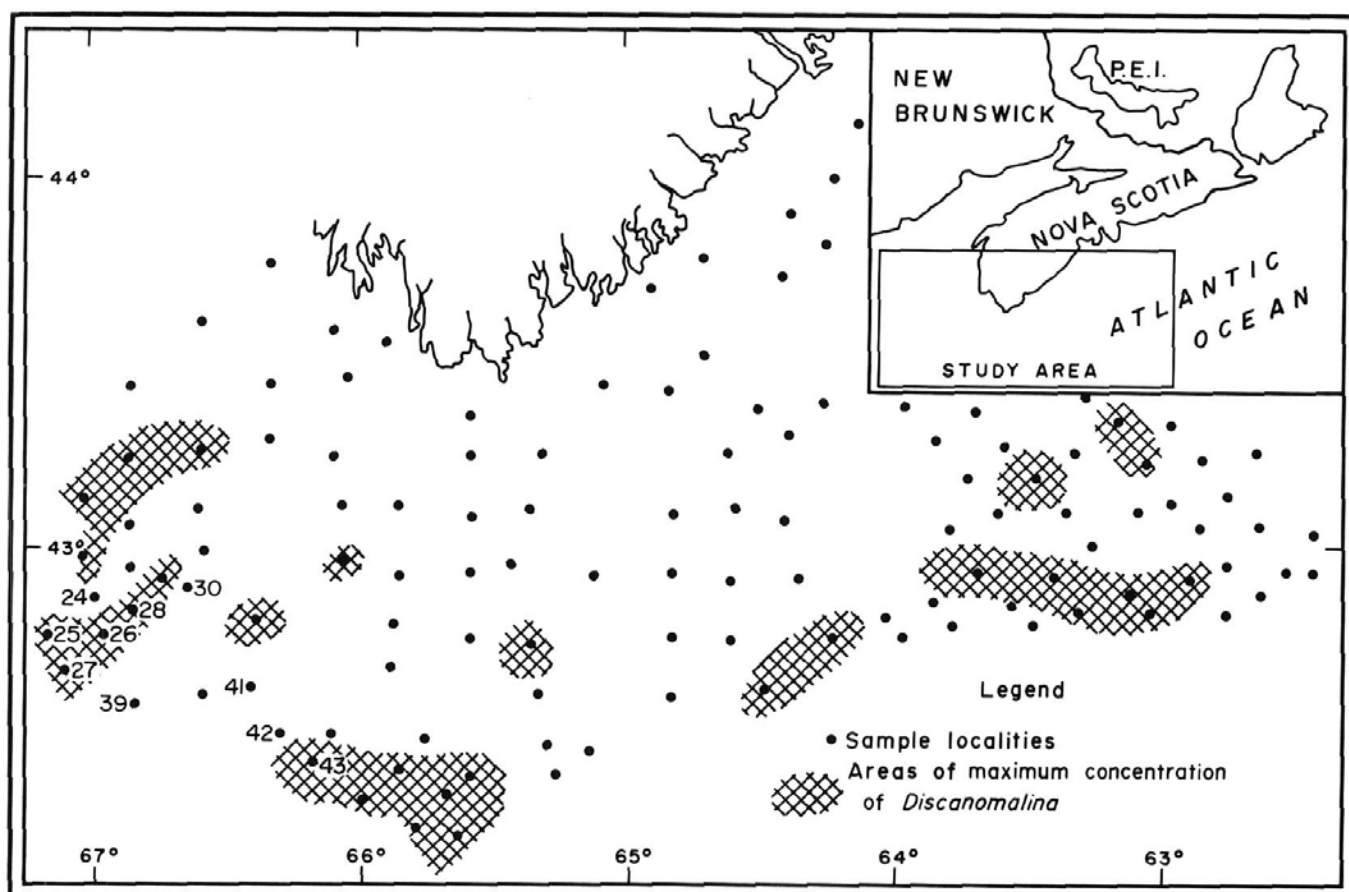
*Discanomalina* Asano, 1951, Test free, thick, planispiral, both sides excavated centrally, spiral side partially evolute, opposite side involute, periphery broadly rounded; chambers inflated, with backward-projecting flap on umbilical side, may have spinelike projections on periphery from one or more chambers; sutures radial; wall calcareous, granular in structure, coarsely perforate on spiral side, umbilical side and apertural face of clear, nonperforate shell material; aperture a low broad equatorial slit, interiomarginal, bordered by slight lip, slitlike supplementary openings may appear beneath umbilical chamber flaps. *Mio.-Rec.*, Japan-Pac.O.-Atl.O.-Carib.

*Paromalina* Loeblich and Tappan, 1957, Test free, planispiral, biumbilicate, both sides somewhat excavated centrally, periphery truncate; chambers laterally inflated, with their umbilical margins extending backward in flaps covering part of previous suture and chamber, flaps more rarely coalescing to obscure the otherwise open umbilicus; sutures radial, depressed; wall calcareous, granular in structure, clear and imperforate on sides and apertural face, coarsely perforate truncate periphery; aperture a broad low slit on periphery, bordered above by narrow lip, at base of final chamber and against preceding whorl, with supplementary openings beneath umbilical chamber flaps on each side of test. [Differs from *Discanomalina* in having the clear imperforate-appearing shell wall on both sides of the test, and by being coarsely perforate only on the truncate periphery.] *Rec.*, Atl.O.

Because the fauna under study was rich in specimens of both groups (text-figure 1) we felt that there was a unique opportunity to attempt to clarify the taxonomic problem, as it appeared to us.

One possible approach was to culture specimens of the two genera, but since these organisms occur in relatively deep water, it would have been extremely difficult to obtain and maintain living cultures.

A second possibility was to do a biometric study; it will be shown later that this method is unnecessarily time-consuming for this group.



TEXT-FIGURE 1

Sampling area. Maximum concentrations of *Discanomalina* and *Paromalina* in shaded portions.

We therefore concluded that the most efficient approach to the solution of this problem was to arrange a large number of specimens in an intergradational morphological series at the ends of which were placed the two most widely divergent forms. If the intergradational series turned out to be clearly interrupted in one (or more) characteristic then there possibly could be more than one species. If the series were completely intergradational then we could feel certain that only one highly variable species existed in our material.

Mayr, Linsley and Usinger (1953, p. 103) stated: "This procedure [of organizing intergradational series] is founded on the correct observation that populations which are connected by intergradation are conspecific, and it jumps from this observation to the reverse conclusion that populations which are not connected by intergradation are not conspecific. The conclusion is correct only so far as sympatric or contiguous populations are concerned [which is the case with the material studied in this paper], because with them the lack of intergradation proves the absence of interbreeding and thus constitutes de facto proof of specific distinctions".

In the sections that follow we intend to present, first our material and an interpretation of the intergradational series, then a comparative analysis of work done by previous authors, followed by discussion and conclusions and, finally, the complete taxonomy of this group.

#### METHODS

The senior author and G. Drapeau collected 185 samples in 1965 and 1966 on the southeast end of the Scotian Shelf (text-figure 1). The samples were not treated with Rose Bengal. Maximum concentrations of population were at depths between 75 and 200 m. (Browns, Baccaro, Roseway and La Have Banks). The samples were first examined by Drapeau who (1971) noticed the large number of *Discanomalina*-*Paromalina* in certain areas. The two genera were present throughout the entire area, which suggested that the samples might have contained a sympatric population.

In our study, the specimens collected from all samples and placed together in the intergradational series are divided, for ease of discussion, into four informal morphological groups which roughly correspond to the

TABLE 1

Percentages of each group from ten samples. Total counted is not necessarily total contained in sample.

Sample no.	24	25	26	27	28	30	39	41	43
Depth (m.)	182	216	168	202	196	196	150	76	237
Total specimens counted	276	227	73	236	282	134	212	170	181
% "bilateralis"	36	48	7	25	30	39	33	12	30
% "coronata"	48	45	47	49	50	45	49	41	44
% "semipunctata"	15	5	45	25	16	16	17	39	24
% "japonica"	.3	.9	1	.8	4	0	.5	7	3

four major species that have been ascribed to such material in the literature.

The series begins with the regular, bilaterally symmetrical group "*bilateralis*" (plate 1, figures 1–4), followed by a slightly less regular and more inflated group indicated as "*coronata*" (plate 1, figures 5–12). The third group, "*semipunctata*," is represented by more or less regular, coiled forms with one side more developed than the other so as to build a planoconvex shape (plate 1, figures 13–16). The last group, "*japonica*," is the most irregular, with spines, irregular coiling, and irregular shape (plate 2, figures 1–20).

In order to roughly assess the relative abundance of the various forms in the population, ten of the richest samples were chosen. In these samples 75 to 300 specimens were counted and grouped into the four main categories. The numerical results are contained in table 1.

## RESULTS

The four groups, although clearly distinct from one another in the central part of their respective spectra of variability, grade into each other at the extremes of those spectra, so that it becomes impossible to place many of the peripheral specimens firmly within any one group.

In plate 1, figures 1, 2 and 3, 4 show the two sides of two specimens; in both cases the opposite sides are the mirror images of each other. These forms, belonging to the group "*bilateralis*," are bilaterally symmetrical (except for few minor irregularities).

The figures 5–12 in plate 1, representing the group "*coronata*," show both sides of specimens which developed progressively smaller umbilici on the dorsal side (plate 1, figures 5, 7, 9, 11). The ventral sides (plate 1, figures 6, 8, 10, 12) on the contrary, remained almost perfectly flat and the supplementary umbilical apertures became progressively more atrophied in the trend away from bilateral symmetry.

Figures 13–16 in plate 1, represent both sides of the group "*semipunctata*." In these forms the clear material on the dorsal side has completely disappeared, whereas the ventral side has become almost featureless.

All these groups appear to have essentially the same

internal structures as shown in figure 18 (plate 1), which is a cross section of the "*bilateralis-coronata*" form shown in figure 17 (plate 1), and by figure 20 (plate 1) which is a cross-section of the "*semipunctata*" form shown in figure 19 (plate 1).

Plate 2 shows all the intermediate degrees of spinosity of the "*japonica*" group.

This evidence strongly suggests that all the specimens shown in plates 1 and 2 belong to the same highly variable species.

Before generalising on this conclusion we shall review the opinions of some previous authors, as well as the geographic distribution of this group of organisms as recorded in the literature.

## HISTORICAL BACKGROUND AND GEOGRAPHIC DISTRIBUTION

Due to their pronounced morphologic variability, forms belonging to the *Discanomalina* and *Paromalina* complex have been attributed, at various times, to quite an array of different species and genera, a list of which is given at the end of the paper.

The oldest record of these forms is that of Bailey (1851) who figured, under the name of *Rotalina semipunctata*, (see plate 3, figures 1–3) a specimen which, because of the trace of a spine on the last chamber, we would attribute to a stage intermediate between "*semipunctata*" and "*japonica*".

In 1856, Costa described what he called *Anomalina polymorpha* (an extremely fortunate trivial name in our opinion) as follows: "*Testa ovali, depressa, laevigata, supra convexa, subtus complanata, umbilicata, varimode incurvata; loculis 6–7 nunc subrectis, convexis, externe carinatis aut rotundatis, saepissime bimucronatis*". Costa's Latin description is undoubtedly appropriate for our group "*japonica*" and his figures (reproduced on plate 3, figures 4–11) seem to confirm this. The more detailed Italian text, however, leaves no doubt that Costa had already noticed the presence of the symmetrical forms which he described quite accurately, commenting (according to our translation) that: "This form varies into so many and varied different shapes that it would be too long and too difficult to describe them all; in general by coiling one side more tightly than the other and by variously twisting . . . [the various specimens] . . . develop different shapes and the chambers extend, usually in opposite sides . . . [of the periphery] . . . into marginal spines; all this without apparent rule . . . ; it looks as if this species lived as a parasite [*sic*] on some marine plants and its twisting was due to the shape of the plant." We emphatically agree with this hypothesis.

In 1857, Parker and Jones, without mentioning either Bailey or Costa, described what they called *Anomalina*

*coronata* as affecting: "... bilateral symmetry, the two surfaces being often nearly equal". It does not seem surprising that they did not mention the two previous authors, for, from these few words, they appear to be talking about an entirely different species; however, they add further on: "The specimen figured is the most symmetrical of the individuals collected; others approach more nearly to the common *Truncatulina*". By "common *Truncatulina*" the authors probably meant the modern *Cibicides lobatulus* (Walker and Jacob) (at the time also known as *Lobatula vulgaris* Thorpe, *Serpula lobatula* Montague and *Truncatulina lobatula* d'Orbigny), which agrees quite well with Bailey's description and figures and reasonably well with Costa's paper in general (except for the lack of any mention of spines).

In 1884 Brady commented on what he considered two different species: *Anomalina coronata* Parker and Jones (see plate 3, figures 12–15), and *Anomalina polymorpha* Costa (see plate 3, figures 16–22). Brady limited his comments to Costa's figures and described *Anomalina polymorpha* as: "A large, coarse shelled variety ... with radial extensions to some of the peripheral segments in the form of stout spines". He obviously overlooked the following comments by Costa: "The regular form of this species ... is composed of 5–6 swollen chambers ... coiled in a spiral without any lateral or median spines ... [which] ... leave a large umbilicus on both sides ...".

In 1931 Cushman, commenting about the spinose forms of *Anomalina semipunctata* Bailey (see plate 3, figures 29–34, = our group "*japonica*") noticed that they: "... as figured by Brady ... often occur with the nonspinose forms, and are evidently variations of the typical in this very variable species." Cushman also described a new subspecies, *Anomalina coronata* Parker and Jones var. *crassa* (see plate 3, figures 23–25).

In 1951 Asano instituted the genus *Discanomalina* to accommodate forms: "... coarsely perforate except for a large area of clear shell material in the umbilical region of the ventral side ..." which, in his opinion, differentiated this genus from *Anomalina*. Asano's type species was clearly designated to be the spinose form, which he called *Discanomalina japonica* (see plate 3, figures 37–39).

In 1965 Ruggieri and Sprovieri placed into this genus *Discorbina perforata* Seguenza, which they considered a junior synonym of *Discanomalina semipunctata* (Bailey).

With the creation of *Discanomalina* the regular bilaterally symmetrical forms were all relegated into *Anomalina* and the nonbilaterally symmetrical, and possibly spinose forms, were lumped together into the new genus *Discanomalina*. Asano, however, placed *Anomalina coro-*

*nata* Parker and Jones (plate 3, figures 35, 36) with the new genus, while, by his own definition, it should have been placed into *Anomalina*.

In 1957 Loeblich and Tappan rightly argued that *A. coronata* Parker and Jones, described by its authors as bilaterally symmetrical, could not be considered *Discanomalina*. Reading Parker and Jones critically, however, makes one wonder what they meant by "*bilateral symmetry*". In fact the two earlier authors had commented that the specimen they had figured was the most symmetrical of the entire collection, whereas the other specimens (= our group "*semipunctata*") were approaching *Cibicides lobatulus* in general shape. It should be noticed here, incidentally, that Asano's *Discanomalina coronata* is almost identical to Brady's (1884) *Anomalina coronata* (see plate 3, figures 13–15) and Cushman's (1931) *Anomalina coronata* (see plate 3, figures 26–28) and none of them is even vaguely bilaterally symmetrical.

In the same 1957 paper Loeblich and Tappan instituted the genus *Paromalina* to accommodate the groups "*coronata*" and "*bilateralis*" (see plate 3, figures 40–41) with clear, imperforate shell walls on both sides of the test, which could not fit into *Discanomalina* Asano.

The creation of these last two genera based on a group of specimens with such a variable morphology is clearly in contrast with Costa's (1856) observation that this group is an array of variations around a basic form, Costa's choice of specimens to figure, however, was singularly unfortunate, particularly considering how well he had understood the problem.

Some of the reports in the literature concerning the distribution of this group of species show that the problems relating to the *Paromalina-Discanomalina* complex are of interest not only on the Scotian Shelf.

Brady (1884), summarizing the known distribution of *Anomalina coronata*, stated that it is: "... very common in certain regions of the North Atlantic especially between Lat. 50° and 70° N; and it also presents itself at several points in the temperate zone of the southern hemisphere, but its occurrence has only been noted at a single locality within the tropics". He gave roughly the same distribution for *Anomalina polymorpha*. In the Pacific Brady's distribution for the same species seems to fall between 20° and 50° S. As for depth, he reported findings between roughly 90 and 1900 m.; however the deepest occurrences appear to be in deep areas close to the slope of continental shelves or of oceanic islands such as: North of the Falkland Islands, off Bermuda, the Azores, the Canaries and other places where presumably the specimens could have been reworked. Brady also reported records of the two spe-



cies in various Late Tertiary deposits in Southern Italy, by Costa and Seguenza.

Subsequent authors did not appreciably modify these distributional data. Cushman (1931) reported his material as occurring in the Atlantic between roughly 20° and 61° N., at depths varying from 210 to 900 m. In 1951 Asano reported his *Discanomalina coronata* and *D. japonica* from the Nojima and Kiwada Formations (Pliocene) of Japan.

#### DISCUSSION

As previously mentioned, measurements of the specimens would certainly have been difficult and probably inconclusive due to the continuous variability of the population. It was therefore decided to forego this exercise and try a simple frequency count of the four major groups. The data of table 1, however, should only be considered an educated estimate of the real values. Although accurate counting was performed on 75 to 300 specimens of the 10 richest samples, the difficulty of firmly identifying at least half of the specimens into any one group makes any attempt at accuracy futile. In our opinion, however, even these "estimates" are meaningful enough to warrant some speculations.

The rather consistently high percentages of "*bilateralis*" and "*coronata*" possibly indicate two things: a) that "*bilateralis*" is the normal form and, as such, quite common under average conditions; b) that, under the same conditions, many forms commonly undergo minor deformations during some stage of their ontogeny and take the shape of "*coronata*".

The relatively uncommon "*semipunctata*" could be indicative of a high energy area where the normally non-attached forms must become attached and adapt morphologically.

The "*japonica*" group was rare in all samples, which suggests that the group represents teratologic forms with no phylogenetic significance.

Speculating on the scarce ecological information in the literature, we suspect that, under unusual conditions, the percentages of "*japonica*" and "*semipunctata*" could increase dramatically. The material from Gallina and Riace (Southern Italy), which will be discussed later, seems to support this hypothesis.

The Scotian Shelf material contains all four groups in significant quantities probably because the area has been exposed during the Pleistocene and, while the sea level was rising, it must have been under varying depth conditions, from intertidal to deep neritic. Since we have no way of differentiating Recent from ancient material, except for the highly unreliable criterion of the appearance of the tests, and as the sedimentation rate in the area seems to be extremely low (Drapeau, 1971),

it appears only sensible to assume that the Scotian Shelf association represents a mixture of the remains of a large number of successive generations, each one living under slightly different conditions. This might explain why a complete and gradual spectrum of variability is present here whereas the other authors were confronted with an incomplete and thus biased record.

As Costa realized in 1856, it appears that these forms may or may not be attached on one side to some foreign object. Depending on the shape of the object and possibly on the age at which attachment takes place, various degrees of deformation can develop; as a general rule the side of the test which is not directly in contact with the substratum tends to grow more vigorously and to coil more tightly around the umbilicus. Inevitably, during this type of growth, one side tends to become flat whereas the other tends to become convex.

All forms can, during their ontogeny, receive injuries of various origin. The organisms seem to react to these injuries by forming irregular chambers and scars in the test which, more often than not, seem to assume the shape of spines of all sizes, shapes, number and positions. As shown in plate 2 these spines vary from tiny structures on top of the last chamber of a "*bilateralis*" (plate 2, figures 1–2) to *Hantkenina*-like spines in early attached, tightly coiled forms (plate 2, figures 19–20). It is possible that the frequency of spines is positively related to the energy in the environment where the animal was living. The distribution of spines in "*japonica*" does not follow any visible pattern. This seems to exclude the possibility that the position and number of spines are genetically controlled, and thus taxonomically significant. This, however, does not exclude the possibility that the spines are a genetically programmed reaction to a stimulus. "*Japonica*", then should be considered a teratological variation.

Although there seems to be widespread agreement in equating the flattened side with the ventral side in many forms (ex. *Cibicides*, *Boldia*, etc.), the same criterion is not necessarily applicable to the "*Paromalina-Discanomalina*" complex and should probably be modified for other attached forms as well. Some of the previous authors called the convex side "dorsal" and the flat one "ventral" (or "spiral" and "umbilical", respectively). Such terminology, in our opinion, is meaningless in planispiral and bilaterally symmetrical forms and in forms which, as a consequence of attachment, have fortuitously lost this type of symmetry (the dorsal side would in fact be either the right or the left side, depending on how the specimen was attached and this would also have implications on the coiling direction of the specimens which cannot be determined for such organisms). The attached and deformed specimens

of bilaterally symmetrical foraminifera should therefore be considered accidental variations with minimal morphological and phylogenetic significance and the terms "right" and "left" should be applied to them as well, when viewed with the plane of symmetry of the specimen in vertical position and the aperture upward and facing the observer.

The *Paromalina-Discanomalina* complex, as previously shown, is distributed widely with a clear, although not strictly limited, preference for temperate-cold water. It appears that these forms are possibly limited to the shelves although, again, reports of occurrences at depths in excess of those of the shelves are not infrequent. Their presence in deeper water, however, could be due to reworking, particularly in those deep areas already mentioned.

Unfortunately, it was not possible to compare the Nova Scotia material with the types of the previous authors. We made an attempt to study at least the fauna described by Costa (1856) but, G. Ruggieri (personal communication) informs us that the outcrop of Carubbare (= marna di Reggio of Costa) originally ascribed to the Pliocene and considered at present Sicilian (middle Pleistocene) in age, cannot be reached any more. Recently, however, through the courtesy of Dr. P. Ascoli, we have been able to study samples from the Pliocene outcrops of Gallina and Riace in southern Italy. These samples convinced us that the Southern Italian and Nova Scotian materials are essentially iden-

tical, although the highly deformed Italian specimens are more abundant than the Nova Scotian ones and show an even more gradual transition to the "*bilateralis*" group.

# CONCLUSION

On the basis of the original material studied plus the Italian material and examination of the literature it seems logical at this point to conclude that the array of genera, species and subspecies discussed in this paper represents one single species, and therefore, must be included in one single genus.

The immediate benefit of this work is the clarification of the taxonomy of one group of highly variable individuals. Its implications are far-reaching for both recent and paleontological studies as there are, both in the contemporary seas and in the geologic record, many taxa which have free and attached forms in the same population.

Attached forms undoubtedly compose a large part of the many synonyms in the micropaleontological literature, mainly because of the high morphological variability caused by their mode of life. These variations may be easily misinterpreted as different species or subspecies.

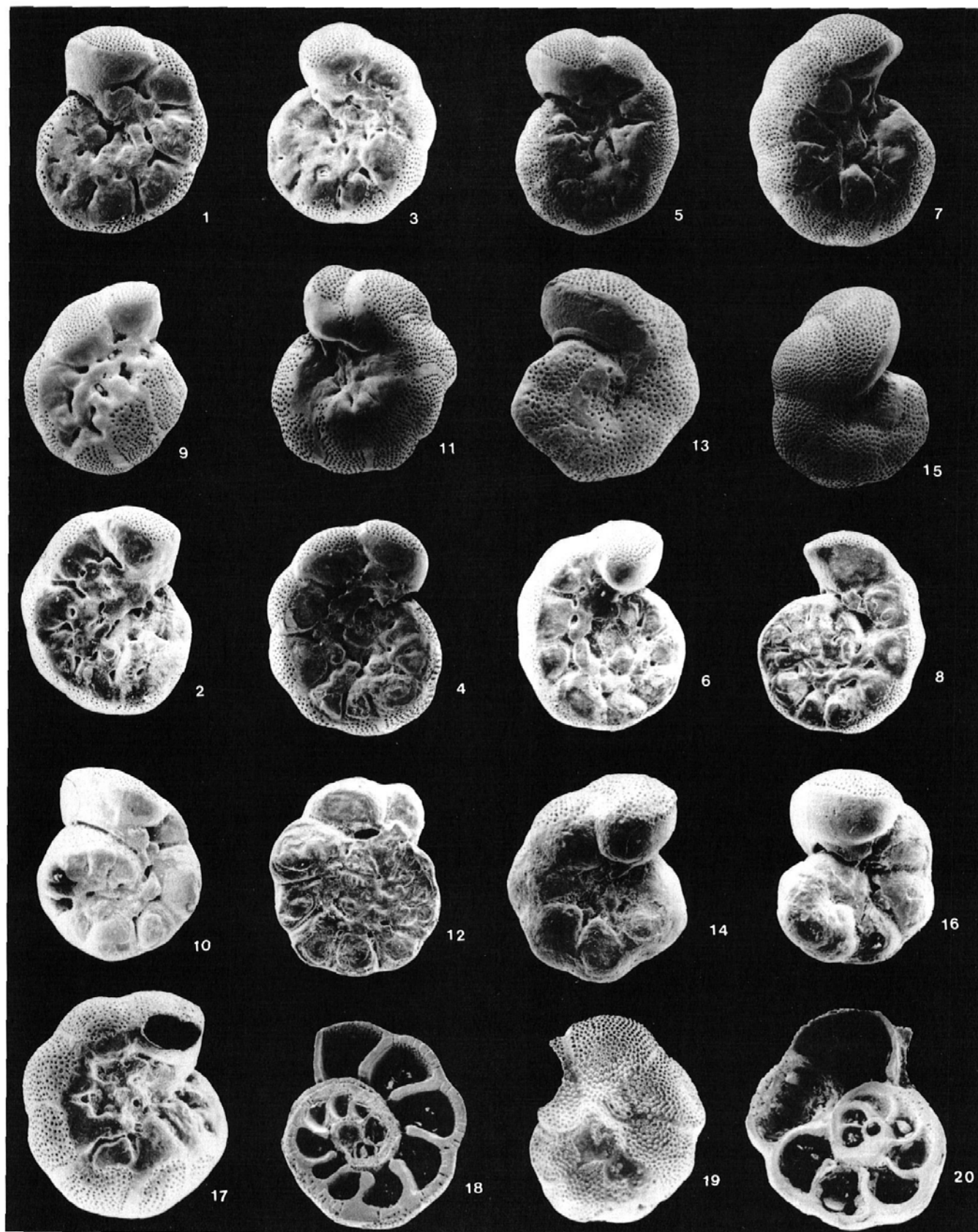
Such taxa require particular attention and it is proposed here that they be studied as assemblages, as it has been done in this paper for the "*Paromalina-Discanomalina*"

## PLATE 1

### *Discanomalina semipunctata* (Bailey)

All magnifications are approximate.

- 1-2 Group "*bilateralis*." 1, right, and 2, left sides of nonattached forms are mirror images of each other,  $\times 38$ .
- 3-10 Group "*coronata*." Umbilical area in these forms becomes progressively smaller on nonattached sides (3, 5, 7, 9) and progressively more flat on attached sides (4, 6, 8, 10). 3-4,  $\times 36$ ; 5-6,  $\times 30$ ; 7-8,  $\times 33$ ; 9-10,  $\times 31$ .
- 11-12 Group "*coronata*" (?). Note perfectly flat left side (12) and almost complete disappearance of clear, umbilical material on nonattached, right side (11),  $\times 32$ .
- 13-14 Group "*semipunctata*" (?). Only remnant of clear material is left on nonattached side (13), and attached side (14) has become featureless,  $\times 30$ .
- 15-16 Group "*semipunctata*". Clear material has completely disappeared from nonattached side (15) and only last two chambers of attached side (16) seem to have remnant of supplementary aperture,  $\times 33$ .
- 17-20 Specimens of "*coronata*" (17-18) and "*semipunctata*" (19-20) have been sectioned to show that there are no major differences in internal structures between these two groups,  $\times 40$ .



complex; this would certainly help to bring about a more realistic and less subjective taxonomy, at least for some groups of foraminifera.

#### TAXONOMIC DISCUSSION

From the previous discussion and from the synonymic list that follows it appears that every specific name given to these forms in the literature after the record of *Rotalina semipunctata* Bailey, 1851 should be considered a junior subjective synonym of that species. According to the International Code of Zoological Nomenclature, however, the name *Rotalina* is itself invalid because it was used by de Blainville in 1828 pro *Rotalia* Lamarck.

The trivial name "*semipunctata* Bailey, 1851", as far as we know, has priority and is still valid.

The other genera in the synonymic list: *Anomalina*, *Planorbulina*, *Truncatulina*, *Discorbina* have type species which are quite familiar to the authors and which do not seem to be congeneric with the forms under study; as such these genera cannot be considered subjective senior synonyms of either *Discanomalina* or *Paromalina*. As mentioned above, the trivial name "*semipunctata* Bailey" is still valid and the following trivial names must be regarded as its subjective junior synonyms:

*polymorpha* Costa, 1856  
*coronata* Parker and Jones, 1857  
*perforata* Seguenza, 1880  
*japonica* Asano, 1951  
*bilateralis* Loeblich and Tappan, 1957

Furthermore *Discanomalina* Asano, 1951 is a senior subjective synonym of *Paromalina* Loeblich and Tappan, 1957. As all the species mentioned before are

subjective junior synonyms of *Rotalina semipunctata* Bailey, 1851, the species under study becomes *Discanomalina semipunctata* (Bailey, 1851). This is not influenced by the fact that the genus *Discanomalina* retains *Discanomalina japonica* Asano as type species.

The genus *Discanomalina* Asano, 1951 and the species *D. semipunctata* (Bailey) now need emendation as follows:

Genus *Discanomalina* Asano, 1951

*Nomenclatural type species: Discanomalina japonica* Asano, 1951. The characteristics of the genus are those of the only species recognized by us, *D. semipunctata* (Bailey, 1851).

*Discanomalina semipunctata* (Bailey, 1851)

*Rotalina semipunctata* BAILEY, 1851, p. 11, figs. 17–19.  
*Anomalina polymorpha* COSTA, 1856, p. 252, pl. 21, figs. 7–9.  
*Anomalina coronata* PARKER and JONES, 1857, p. 294, pl. 10, figs. 15–16.—\*BRADY, 1864, p. 469, pl. 48, figs. 13a–b (*vide* Cushman, 1931).  
*Planorbulina farcata* var. (*Anomalina*) *coronata* PARKER and JONES (*sic*), 1865, p. 383, pl. 14, figs. 7–11 (*vide* Cushman, 1931).  
*Discorbina perforata* SEGUENZA, 1880, p. 148, pl. 14, figs. 3, 3a.  
*Anomalina polymorpha* Costa.—BRADY, 1884, p. 676, pl. 97, figs. 3–7.  
*Anomalina coronata* Parker and Jones.—BRADY, 1884, p. 675, pl. 97, figs. 1–2.—\*FORNASINI, 1893, pl. 2, fig. 17 (*vide* Cushman, 1931).  
\**Planorbulina coronata* GOËS, 1894, p. 90, pl. 15, figs. 781–783.  
\**Anomalina polymorpha* Costa.—FLINT, 1899, p. 336, pl. 79, fig. 3 (*vide* Cushman, 1931).  
\**Anomalina coronata* Parker and Jones.—FLINT, 1899, p. 335, pl. 79, fig. 2 (*vide* Cushman, 1931).  
\**Anomalina coronata* Parker and Jones.—CHAPMAN, 1909, p. 360, pl. 17, fig. 10 (*vide* Cushman, 1931).

\*Not directly consulted by us.

#### PLATE 2

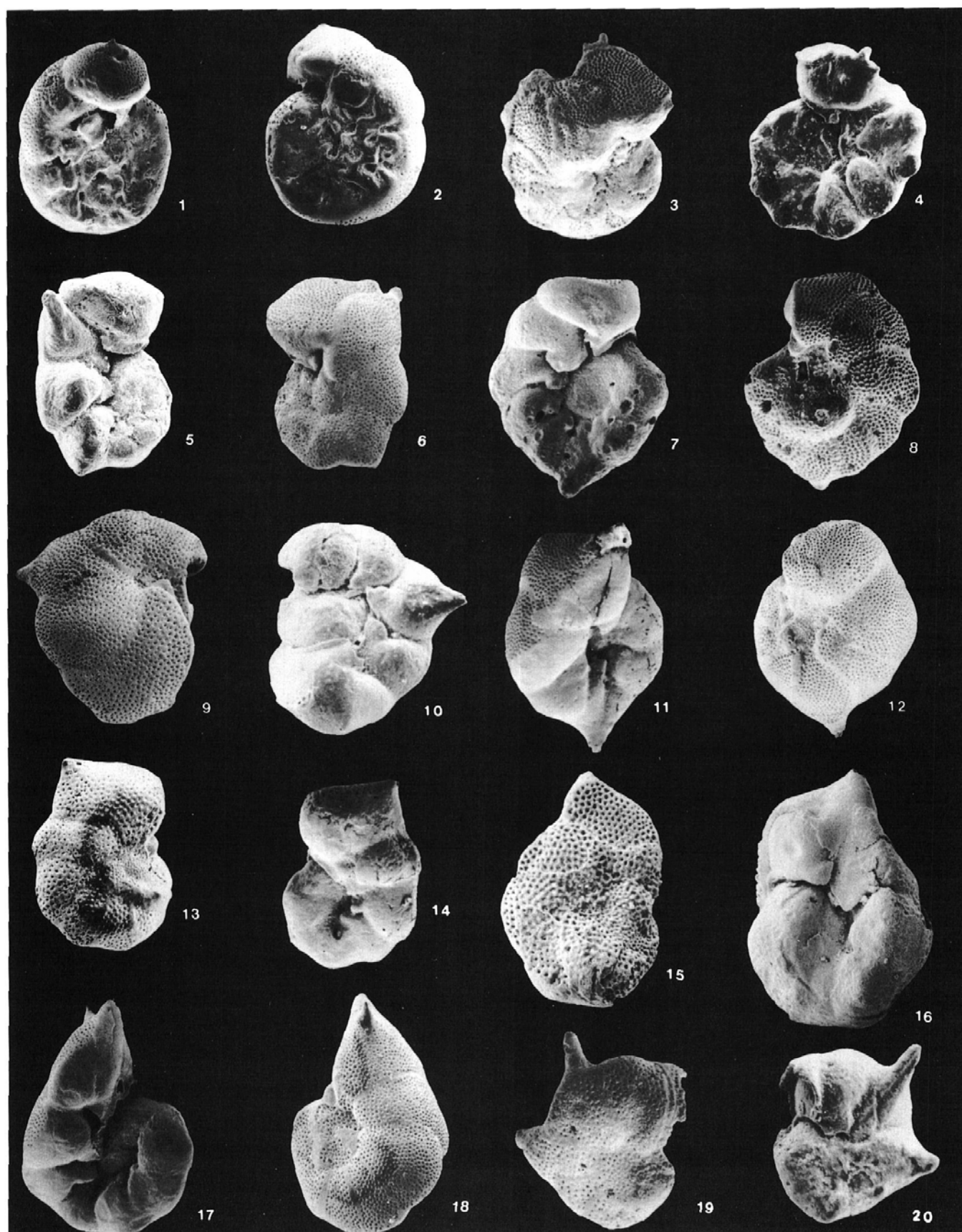
*Discanomalina semipunctata* (Bailey). All can be attributed to the group "*japonica*".

All magnifications are approximate.

- 1–2 Were it not for the tiny spine on the last chamber, this specimen would be considered "*bilateralis*". Spinose "*bilateralis*" are rare in the Scotian Shelf material, but more common among Southern Italian specimens,  $\times 35$ .
- 3–4 These specimens show some characteristics of "*coronata*",  $\times 33$ .
- 5–6  $\times 35$ .

- 7–8 Large perforations appear to be probable cause of death; therefore no spines were formed in injured areas,  $\times 44$ .
- 9–12  $\times 39$ .
- 13–14  $\times 43$ .
- 15–16  $\times 54$ .
- 17–18  $\times 33$ .
- 19–20  $\times 50$ .





- \**Anomalina polymorpha* Costa.—HERON ALLEN and EARLAND, 1915, p. 712, pl. 53, figs. 2–5 (*vide* Cushman, 1931).—CUSHMAN, 1915, p. 47, pl. 19, figs. 3–4.  
*Anomalina coronata* Parker and Jones.—CUSHMAN, 1915, p. 47, pl. 18, fig. 5.  
*Anomalina polymorpha* Costa.—CUSHMAN, 1921, p. 324, pl. 61, figs. 3a–b.  
*Anomalina polymorpha* Costa var. *cervicornis* CUSHMAN, 1921, p. 325, pl. 62, figs. 1a–b.  
*Anomalina polymorpha* Costa var. *siphonifera* CUSHMAN, 1921, p. 325, pl. 62, figs. 2a–b.  
*Anomalina coronata* Parker and Jones.—CUSHMAN, 1921, p. 326, pl. 61, figs. 2a–c.—\*CUSHMAN and WICKENDEN, 1929, p. 14, pl. 6, figs. 9a–c (*vide* Cushman, 1931).  
*Anomalina semipunctata* Bailey.—CUSHMAN, 1931, p. 106, pl. 18, figs. 1–2.  
*Anomalina coronata* Parker and Jones var. *crassa* CUSHMAN, 1931, p. 105, pl. 19, figs. 1–2.  
*Discanomalina coronata* (Parker and Jones).—ASANO, 1951, p. 13, figs. 1–2.  
*Discanomalina japonica* ASANO, 1951, p. 13, figs. 3–5.  
*Anomalina semipunctata* (Bailey).—AGIP MINERARIA, 1957, pl. 50.  
*Paromalina bilateralis* LOEBLICH and TAPPAN, 1957, pp. 230–231, pl. 73, figs. 12–31.—BARBIERI and MEDIOLI, 1969, p. 861, fig. 6.  
*Discanomalina semipunctata* (Bailey).—RUGGIERI and SPROVIERI, 1965, p. 957, pl. 93, figs. 5a, c.

*Description:* Test free or attached. When free it tends to become planispiral, with two broad umbilici and a truncate periphery. The chambers usually become laterally inflated and extend more or less toward the

center of the umbilici in the form of flaps which in part cover supplementary apertures. Sutures radial and depressed; the calcareous wall of the sides and of the apertural face becomes clear and imperforate whereas the truncate periphery is coarsely perforate. The main aperture, in both free and attached forms, is a broad, low slit, more or less regular in shape, at the base of the last chamber and reaching over the periphery.

When attached this species tends to maintain the clear, imperforate calcareous wall on the attached side, while the nonattached side tends to coil more tightly, reducing the size of its umbilicus which, in extreme cases, disappears almost completely.

The attached side is often completely flattened and its supplementary apertures tend to atrophy and disappear.

On the nonattached side, in addition to the progressive reduction of the umbilicus, there is also a tendency for the truncate peripheral, coarsely perforate wall to migrate toward the center of the side. In extreme cases the specimen becomes planoconvex with a coarsely perforate convex side. In both attached and free forms, spines, presumably due to injuries, are commonly present.

This appears to be the only species of the genus *Discanomalina* Asano.

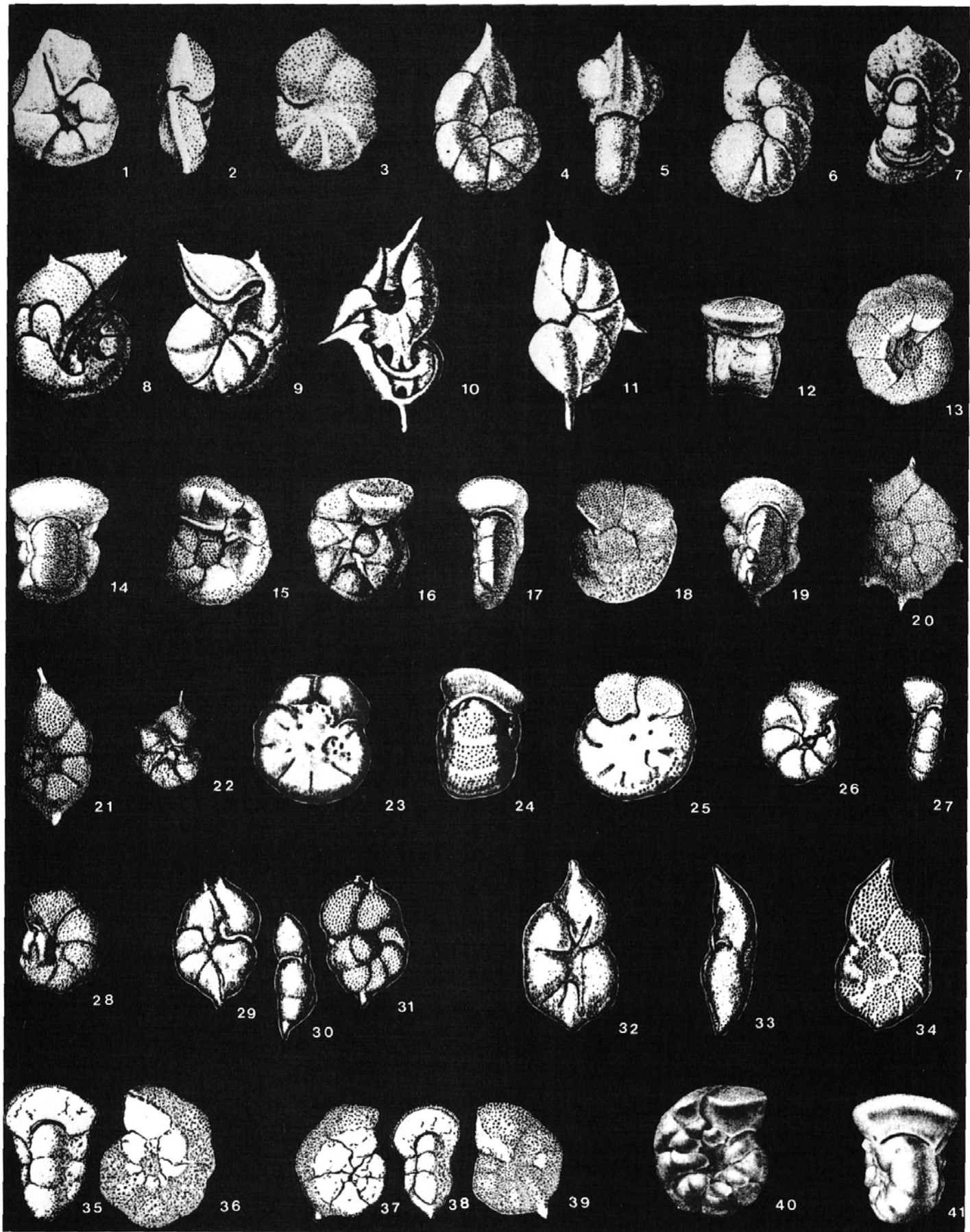
*Distribution:* Miocene–Recent.

\*Not directly consulted by us.

### PLATE 3

All magnifications are approximate.

- |   |   |
|---|---|
| 1–3 <i>Rotalina semipunctata</i> Bailey (From Bailey, 1851), × 27. (?)                                  | 26–28 <i>Anomalina coronata</i> Parker and Jones (?) (From Cushman, 1931), × 21.                |
| 4–11 <i>Anomalina polymorpha</i> Costa (From Costa, 1856), × 23. (?)                                    | 29–31 <i>Anomalina semipunctata</i> (Bailey) (From Cushman, 1931), × 28.                        |
| 12 <i>Anomalina coronata</i> Parker and Jones (From Brady, 1884), × 26.                                 | 32–34 <i>Anomalina semipunctata</i> (Bailey) (From Cushman, 1931), × 25.                        |
| 13–15 <i>Anomalina coronata</i> Parker and Jones (From Brady, 1884), × 20.                              | 35–36 <i>Discanomalina coronata</i> (Parker and Jones) (From Asano, 1951), × 25.                |
| 16–18 <i>Anomalina polymorpha</i> (?) Costa (From Brady, 1884), × 24.                                   | 37–39 <i>Discanomalina japonica</i> Asano (From Asano, 1951), × 23.                             |
| 19–21 <i>Anomalina polymorpha</i> Costa (From Brady, 1884), × 24.                                       | 40–41 <i>Paromalina bilateralis</i> Loeblich and Tappan (From Loeblich and Tappan, 1957), × 30. |
| 22 <i>Anomalina polymorpha</i> Costa (From Brady, 1884), × 18.  |   |
| 23–25 <i>Anomalina coronata</i> Parker and Jones var. <i>crassa</i> Cushman (From Cushman, 1931), × 27. |   |



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