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Miogypsinid Foraminiferal Biostratigraphy from the Oligocene to Miocene Sedimentary Rocks in the Tethys Region

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1. Introduction

Tan Sin Hok (1936, 1937) has done the anatomical and morphometrical analysis of the family Miogypsinidae at the first time. This is regarded as the important contribution for the Micropaleontology on foraminiferal studies. His studies have developed from the phylogenetic history of the genus *Cycloclypeus* and their relative species of the family Nummulitidae de Blainville, 1827 (Tan Sin Hok, 1932). The basic materials of these two families have been gathered based on detailed geological fieldworks of many geologists for a long time from the East Indies (Indonesia and its surroundings) as eastern Tethys region or Indo – Pacific region. Therefore the research results of Miogypsinid foraminiferal Biostratigraphy through Tan Sin Hok's morphogenetic method could compare easily with the results of Miogypsinid foraminiferal biostratigraphic research from many areas (Drooger, 1993).

The purpose of this study is to describe the introduction of the Miogypsinid foraminiferal Biostratigraphy and its evolutional lineage based on the author's research and other colleagues results, and research of materials from three areas (Maraş, Palu, and Muş) of Menderes – Taurus Platform, Turkey, respectively.

2. Method of study

All microscopical studies were conducted by examination of all sectioned foraminiferal specimens from sample materials collected from the biostratigraphial columnar sections or spot samplings in order to reinforce the space and time distribution of species. Concerning to the observation of outer and inner structure of the foraminiferal test, the microscope used had the lens combination from x 20 to x 200. The biometrical measurement of the equatorial sectioned nucleoconch and peri-nucleoconchal chambers were made by means of a curvimeter and/or scale protractor from a drawing or direct thin section of the nucleoconch and peri-nucleoconchal chambers at magnification of x 200. The present study is based on the sectioned specimens and free specimens, which were collected from various localities and/or drill core in Japan, Taiwan, and Turkey.

In the present paper, the morphological terms used are given in the glossary and the important criteria for detailed measurements (Figure 1). The measurements were taken from the equatorial and axial (= vertical) sections of megalospheric specimens which exhibited considerable variations in measurements. Also those of microspheric specimens are used supplementary for the measurements and for observation of structure. Since all characters are not measurable, the statistical analysis and consideration from measurements are not perfectly alternative to traditional description, but merely supplementary to it, but provides a more objective basis for comparison between the measurable characters of important morphology and/or structure. The measured parameters are explained for the following terminology as defined by many authors (Figure 1).

On nucleoconch (= embryonic chambers), as showing the development of embryonic chambers is explained as below.

DI: diameter of protoconch, the first chamber of embryonic chambers, consisting protoconch and deuteroconch (Figure 1a). Generally inner protoconch is measured at right angle for the center line of both protoconch and deuteroconch. DI is Drooger's (1952) symbol or definition. The next two is also his symbol and definition.

DII: diameter of duteroconch, the second chamber of embryonic chambers (Figure 1a).

DII/DI: ratio of diameter between protoconch and deuteroconch.

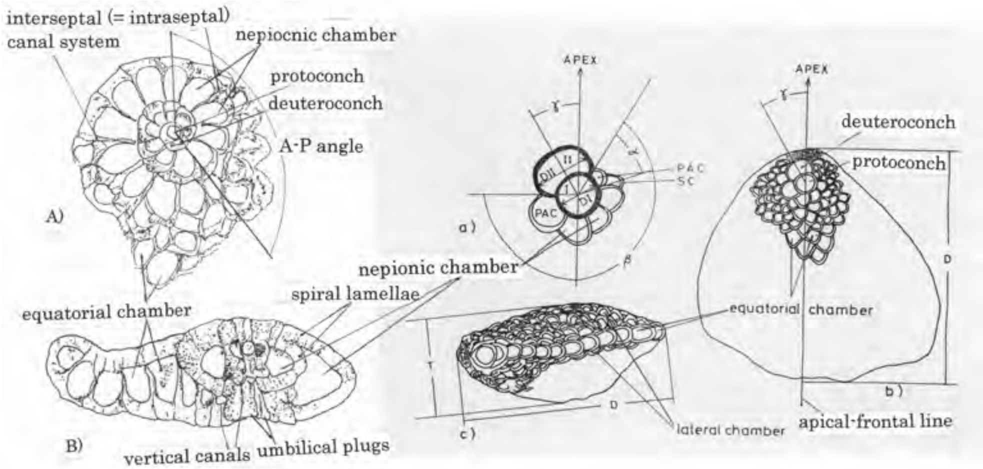

Fig. 1. Terminology of the Miogypsinid foraminifera. A. Equatorial section of *Miogypsinella boninensis* Matsumaru, and B. Axial (= Vertical) section of *Miogypsinella boninensis* Matsumaru. a. Enlargement of the apical portion of equatorial section of *Miogypsina globulina* (Michelotti). b. Equatorial section of *Miogypsina globulina* (Micgelotti). c. Axial (=Vertical) section of *Miogypsina globulina* (Michelotti). I = protoconch. II = deuteroconch. PAC = principal auxiliary chamber. SC = symmetrical (= closing) nepionic chamber. DI = diameter of protoconch. DII = diameter of deuteroconch. α = angle between a line joining the center of the protoconch and the junction of both walls of the protoconch and deuteroconch, and another line connecting the said center and a mid-point of the posterior wall of the symmetrical chamber. ß = angle representing the whole development area of both nepionic spirals of the protoconch surround with both spirals starting from both PAC. V = 200 α/ß = indicate from the absence of the second PAC representing by the value 0 to the protoconchal spirals of equal length by the value 100. γ = angle between the apical – frontal line and line joining the center of the protoconch and deuteroconch.

On nepionic chambers, as base character of the principle of nepionic acceleration (including nepionic retardation, but with additional development of new nepionic spirals) by Tan Sin Hok's (1936, 1937) theory is explained as below.

Parameter X: number of spiral nepionic chambers developed in peri-nucleoconch (= peri-embryonic chambers). This is Tan Sin Hok's (1936) "*Rotalia*-Anfang und mit intraseptalen Spalten". Drooger (1952) counts and used as one of important characters as symbol or definition, parameter X. The value X is progressed until the new nepionic spirals of parameter α as stated below. In the genus *Miogypsinella* with trochoid spirals (Figure 2, top left) and genus *Miogypsinoides* with planispiral (Figure 2, top right), the nepionic chambers are counted in number as parameter X in a spiral arrangement. This is continued until the presence of *Miogypsina primitiva* (Tan Sin Hok) (Figure 2, second left from top), which is considered to be the genus *Miogypsinopsis* Hanzawa, 1940, and *Miogypsina borneensis* Tan Sin Hok, 1936. The number of parameter X is getting decrease from *Miogypsinella boninensis* Matsumaru, 1996 (Figure 1A, X = 25) to *Miogypsina primitiva* (Figure 2, X = 10) and *Miogypsina borneensis* (Plate 2, figures 1-3, X = 6), and it is regarded as nepionic retardation. The next step is beginning at the development of secondary nepionic spirals from the second prinicipal auxiliary chamber and situated in the opposite side of the primary principal auxiliary chamber (Figure 1a; parameter α). Therefore this evolutionary lineage is generally regarded as Tan Sin Hok's (1936, 1937) nepionic acceleration from the genus *Miogypsinella* to genus *Miogypsina*. The following four parameters are based on Drooger (1952, 1963).

Parameter α: small nepionic spiral developed from the second principal auxiliary chambers (Figure 1a). This is the secondary or short nepionic spirals, situated under the outer wall of protoconch. This spiral is arc length and measured by the angle between the line connecting the center of protoconch and rough inscribed line touchrd between deuteroconch and second principal auxiliary chamber, and the line connecting the center of protoconch and center line of closing chamber, which is situated between large and small nepionic spirals developed from opposite direction of two principal auxiliary chambers (Figure 1a). Parameter α in Figure 1a = 40^{o}.

Parameter ß: total nepionic spirals including a closing chamber (= symmetrical chamber, Figure 1a, sc) under the outer wall of protoconch, developed from two primary and secondary principal auxiliary chambers. This spiral is also arc length and measured by the angle between two rough inscribed lines from both two principal auxiliary chambers and deuteroconch, connecting with the center of protoconch (Figure 1a). Parameter ß in Figure 1a = 240^{o}. Generally the primary or long nepionic spirals from the primary principal auxiliary chamber is larger arc than the secondary or short nepionic spirals.

Parameter V (= 200 α/ß): ratio of small or short nepionic spirals (α) for total short and long nepionic spirals (ß), and parameter α will be stopped at the midpoint of parameter ß. Then the ratio times 200 are expressed as a continuous scale with units from 0 to 100. When a closing or symmetry chamber is situated at the midpoint of both protoconchal nepionic spirals, V value is indicated as 100. When a short nepionic spiral or a closing chamber isn't present, V value is indicated as 0. Parameter V in Figure 1a = $40^{o}/240^{o}$ x 200 = 33.332. When measuring these parameters in numerous specimens in a sample, there is sometimes exceed over 100 in V value, but it is few case.

Parameter γ: angle between the apical-frontal line of test through the center of protoconch and the line connecting centers of embryonic chambers (Figure 1b). If the primary principal auxiliary chamber is situated below the line connecting of centers of embryonic chambers, parameter γ is positive, and reverse is negative (Plate 2, figure 2). Parameter γ in Figure 1a = positive 30^{o}.

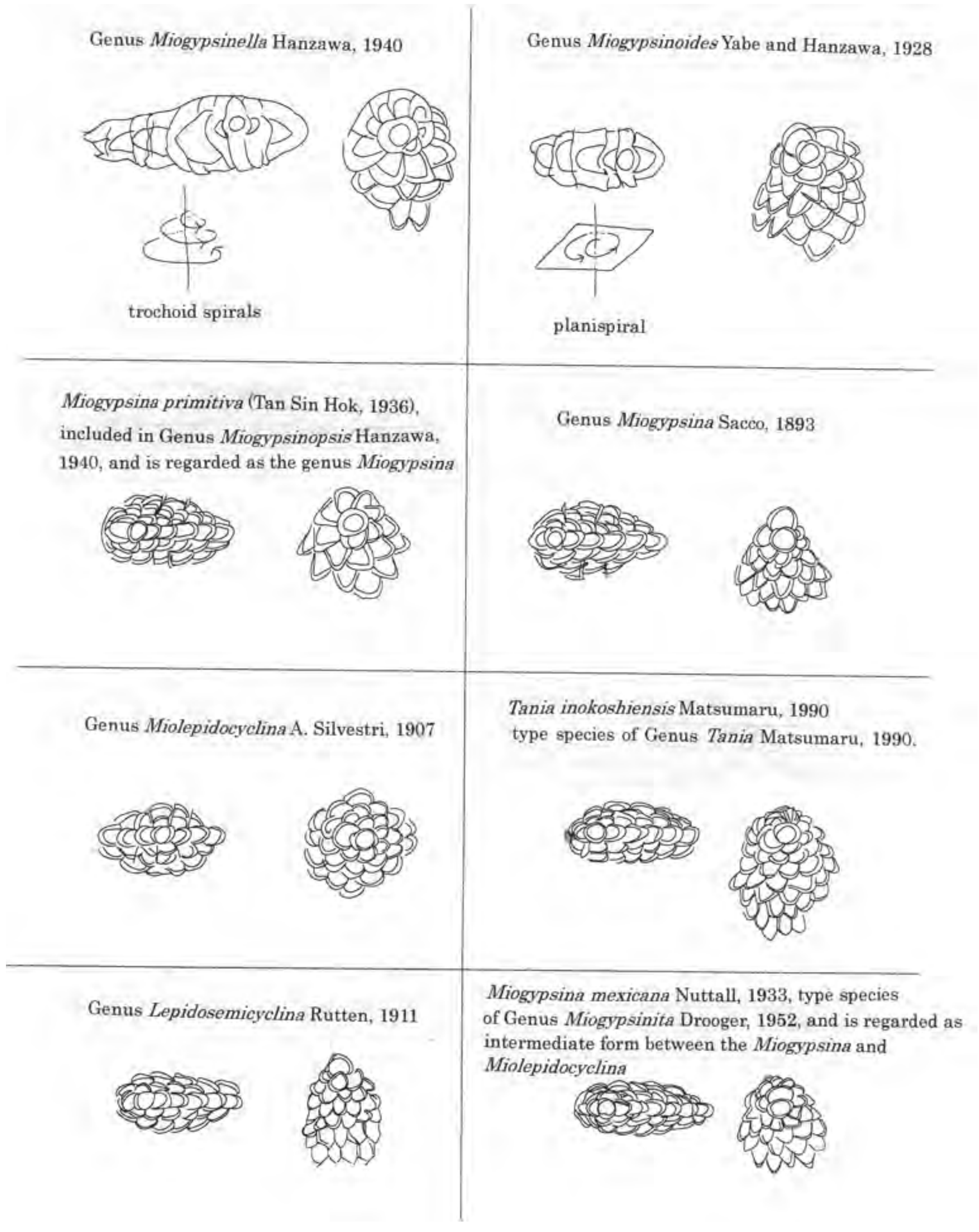

Fig. 2. Sketch of several genera and species of the family Miogypsinidae Vaughan, 1928 in the Tethys region. Two nepionic spirals are shown as trochoid spirals and planispirals.

Parameter A-P angle: arc length of nepionic spirals starting from embryonic chambers, and ending to the apical point of test (Hanzawa, 1957, p. 91; table 6), and A-P angle in Figure 1A , AP = $360^o + 145^o = 505^o$.
Designation of the species: In the previous investigation by many authors, the species units of miogypsinid foraminifera have mainly been established by applying from the mean X value to mean V value (mean X – mean V value scale), in addition to traditional main observation, i.e. presence and/or absence of lateral chambers, shape and arrangement of equatorial chambers, arrangement of stolons and canal system in chamber walls, and development of pillars and/or sometimes spines. Species of Figure 1A, B is *Miogypsinella boninensis* Matsumaru, carrying Parameter X (X = 25) and A-P angle (AP = 505^o), and that of Figure 1 a-c is *Miogypsina globulina* (Michelotti), carrying Parameter V (V = 33.3) and Parameter γ ($\gamma = + 30^o$). Parameter X exists until 5, and doesn't exist 4.

3. Stratigraphy, faunal succession, and correlation

In this chapter, the author describes the introduction of the fundamental Miogypsinid foraminiferal Biostratigraphy, faunal succession and phylogenetic lineage, and correlation.
1. Ogasawara Islands, Japan
The basal Oligocene carbonate sedimentary rocks in Japan has been known in Chichi-Jima (island) and Minami-Jima, Ogasawara Islands, Japan (Matsumaru, 1996) (Figures 4-7). In there, six stratigraphic sections in the Minamizaki cape, SW of Chichi-Jima, and two stratigraphic sections and several spot samplings in the Minami-Jima, Ogasawara Islands were examined for the larger foraminiferal biostratigraphy of the Minamizaki Limestone (Formation) with maximum 244 m thick, overlying the basement volcanic rocks (boninite, andesite, dacite, and others) (Figures 5-6). Two larger foraminiferal assemblages (Assemblage IV and Assemblage V) during Oligocene age were recognized in the respective sections of biostratigraphic sequence, based on the stratigraphic range of larger and smaller foraminifera in association with planktonic foraminifera. The Assemblage IV is the *Eulepidina dilatata* (Michelotti) - *E. ephippioides* (Jones and Chapman) - *Heterostegina borneensis* van der Vlerk Assemblage and the Assemblage V is the *Miogypsinella boninensis* - *Spiroclypeus margaritatus* (Schlumberger) - *Austrotrillina howchini* (Schlumberger) Assemblage. Both assemblages were correlative with Tertiary c and/or Tertiary d, and Tertiary e1-2 to Tertiary e4 of the East Indies Letter Stages (Leupold and van dr Vlerk, 1931), respectively, and were also correlative with Zone P 18?-21 or *Globigerina sellii* (Borsetti) Zone – *Globorotalia opima opima* Bolli Zone, and Zone P 21? or P 22 of planktonic foraminiferal zonations. The Assemblage IV is correlated with the fauna of the Tertiary beds of 1629 to 2687 feet, in Eniwetok Atoll Drill Holes (Cole, 1957), and 1723.5 to 2359.5 feet, in Bikini Atoll Drill Holes (Cole, 1954), respectively, because of the coexistence and range of *Eulepidina ephippioides* (Jones and Chapman), *Heterostegina borneensis* van der Vlerk, *H. duplicamera* Cole, and *Halkyardia minima* (Liebus) (Figure 4). The Assemblage V is also correlated with Tertiary e limestones in bore-holes at Eniwetok Atoll Drill Holes at depth from 1210 to 1599 feet, and at Bikini Atoll Drill Holes at depth from 1597.5 to 1671 feet, respectively, where *Miogypsinella grandipustula* (Cole) and *Miogypsinella ubaghsi* (Tan Sin Hok) were reported by Cole (1954, 1957) (Figure 4).
Two assemblages (IV and V), Ogasawara Islands are referable in the geological age to Early to late Early Oligocene, and early Late Oligocene, respectively (Figures 6-7). According to Kaneoka et al. (1970) and Tsunakawa (1983), K-Ar radiometric ages on boninite, andesite,

dacite and quartz dacite of basal volcanic rocks of Chichi-Jima, Ogasawara Islands is regarded as 43.0 to 29.4 Ma, and the most young age of volcanics is 26.7 Ma. The Minamizaki Limestone is regarded as submerged karst topography, with summits sticking up from the sea as peninsulas of Minamizaki Cape, Chichi-Jima and Minami-Jima (island) and a lot of islets. The largely submerged Minamizaki Limestone is estimated to be more than 244 m thick and overlies the basement volcanic rocks of lavas and pyroclastics of boninite and other rocks as stated above.

The Assemblage IV is at least regarded as Tertiary d, in this study, due to occurrence of *Heterostegina borneensis* van der Vlerk, *H. duplicamera* Cole, *Eulepidina dilatata* (Michelotti), *E. ephippioides* (Jones and Chapman), *Pararotalia mecatepecensis* (Nuttall), *Paleomiogypsina boninensis* Matsumaru, *Borelis pygmaeus* (Hanzawa) and *Nephrolepidina marginata* (Michelotti), with associated planktonic foraminifera of Zone P 21(Blow, 1969) such as *Globorotalia opima nana* Bolli, *G.* cf. *opima opima* Bolli, and *G.* gr. *opima* Bolli. They are correlated with the Late Eocene to Neogene time scale (official website of ICS, 2004; Berggren et al., 1995) (Figures 6-7, 9). The Assemblage V is assigned to Tertiary e1-2 to Tertiary e3, in this study, due to occurrence of *Miogypsinella boninensis* Matsumaru, *Spiroclypeus margaritatus* (Schlumberger), *Cycloclypeus eidae* Tan Sin Hok, which is junior synonym of *C. koolhoveni* Tan Sin Hok and/or *C. oppenoorthi* Tan Sin Hok, *Paleomiogypsina boninensis, Boninella boninensis* Matsumaru, *Flosculinella reicheli* Mohler, which is a synonym of *Flosculinella globulosa* Rutten, and *Austrotrillina howchini* (Schlumberger). This fauna didn't associate with diagnostic planktonic foraminifera, but it should be assumed to be Zone P 22 from the biostratigraphical occurrence (Figure 6). Although the basal part of the Minamizaki Limestone is obscure due to subsidence under the sea, *Pararotalia mecatepecensis* may evolve into *Paleomiogypsina boninensis* due to nepionic acceleration and well-developed subsidiary chambers during early Oligocene (Rupelian) and/or latest Eocene (Priabonian?) due to basal volcanic radiometric age (Figures 3-4, 7). Also *Paleomiogypsina boninensis* evolved into *Miogypsinella boninensis* due to biostratigraphical occurrence, Tan Sin Hok's nepionic acceleration, and development of equatorial chambers (Figures 3-4, 7). *Miogypsinella boninensis* has the character of number of nepionic chambers (mean X = 27) and A-P angle (mean AP = 578°) (Figure 4).

2. Komahashi-Daini Seamount, Japan

The larger foraminiferal assemblage has been discovered from limestone blocks dredged at two sites on the Komahashi-Daini Seamount of the Kyushu-Palau Ridge, Japan (sample DG-04-01; 30°02.98´N. lat., 133°19.88´E. long.; sample DG-05-02; 29°53.98´N. lat., 133°22.66´E. long.; Mohiuddin et al., 2000) (Figure 5). The assemblage is dominated by the occurrence of *Miogypsinella ubaghsi* (Tan Sin Hok), *Spiroclypeus margaritatus*, *Heterostegina borneensis, Eulepidina dilatata, E. ephippioides, Nephrolepudina marginata,* and *Austrotrillina howchini,* and was correlated with the top part of the Minamizaki Limestone of Ogasawara Islands. In this study, the Komahashi-Daini larger foraminiferal fauna may be regarded as the fauna from the covering limestone of the Minamizaki Limestone, Ogasawara Islands, because *Miogypsinella ubaghsi* didn't occur from the top member of the Minamizaki Limestone (Figures 4, 6-7). *Miogypsinella ubaghsi* has the character such as number of nepionic chambers (X = 21) and A-P angle (AP = 395°) (Mouhiddin et al, 2000, fig.8-3). Judging from the stratigraphic correlation and nepionic acceleration, *Miogypsinella boninensis* evolved into *Miogypsinella ubaghsi* as the author's consideration (Matsumaru, 1996, p. 39, fig. 24) (Figure 4).

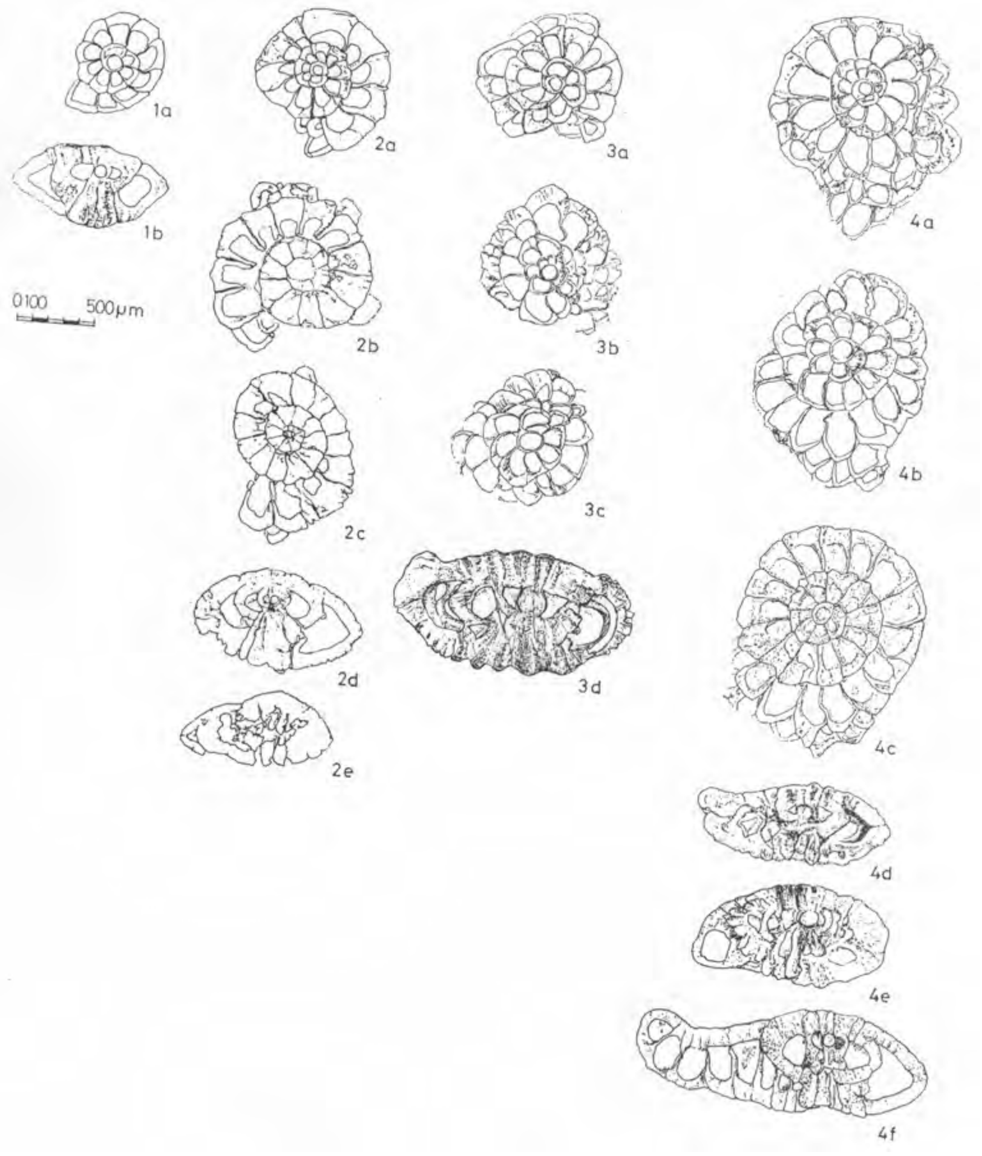

Fig. 3. Drawings of the embryonic, nepionic, and neanic stages in the equatorial and axial sections of species of: 1. *Pararotalia mecatepecensis* (Nuttall), 2. *Paleomiogypsina boninensis* Matsumaru, 3. *Boninella boninensis* Matsumaru, 4. *Miogypsinella boninensis* Matsumaru (Matsumaru, 1996, fig. 23).

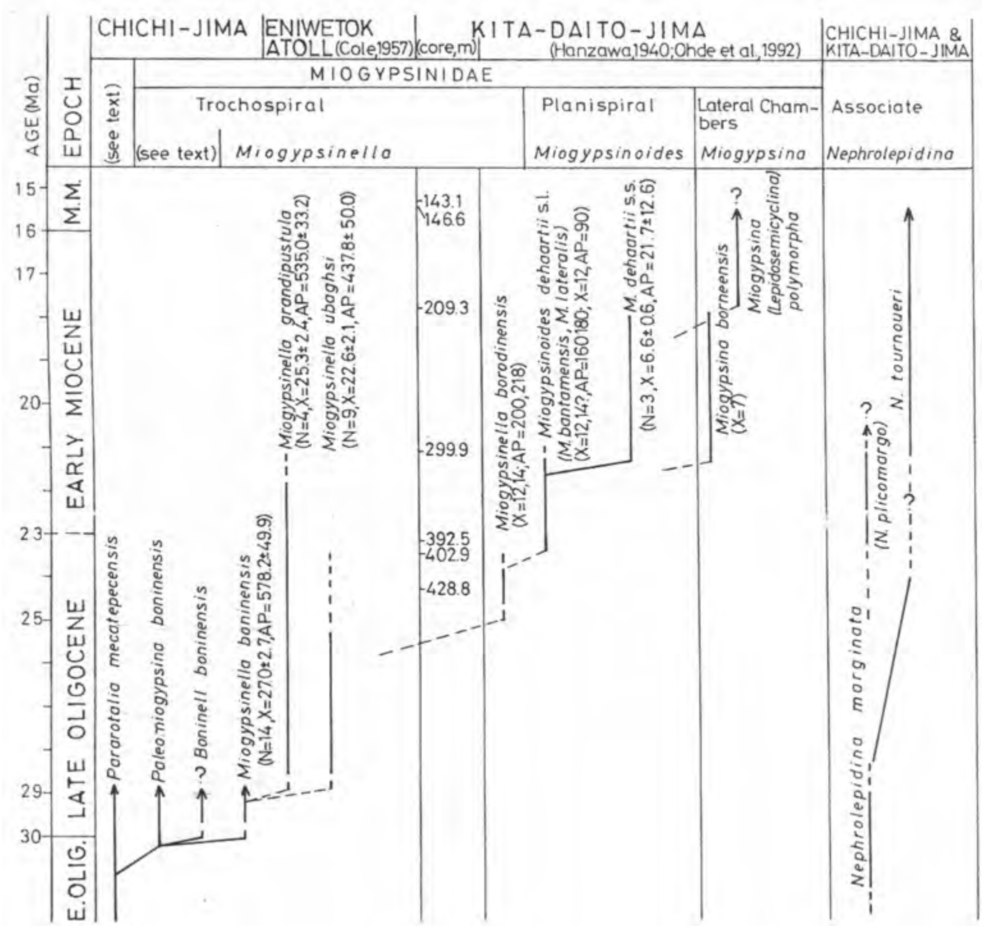

Fig. 4. Evolution of the western Pacific Miogypsinids from Chichi-Jima, Eniwetok Atoll, and Kita-Daito-Jima, and the stratigraphic position of associated *Nephrolepidina* species from Chichi-Jima and Kita-Daito-Jima (Matsumaru, 1996, fig. 24).

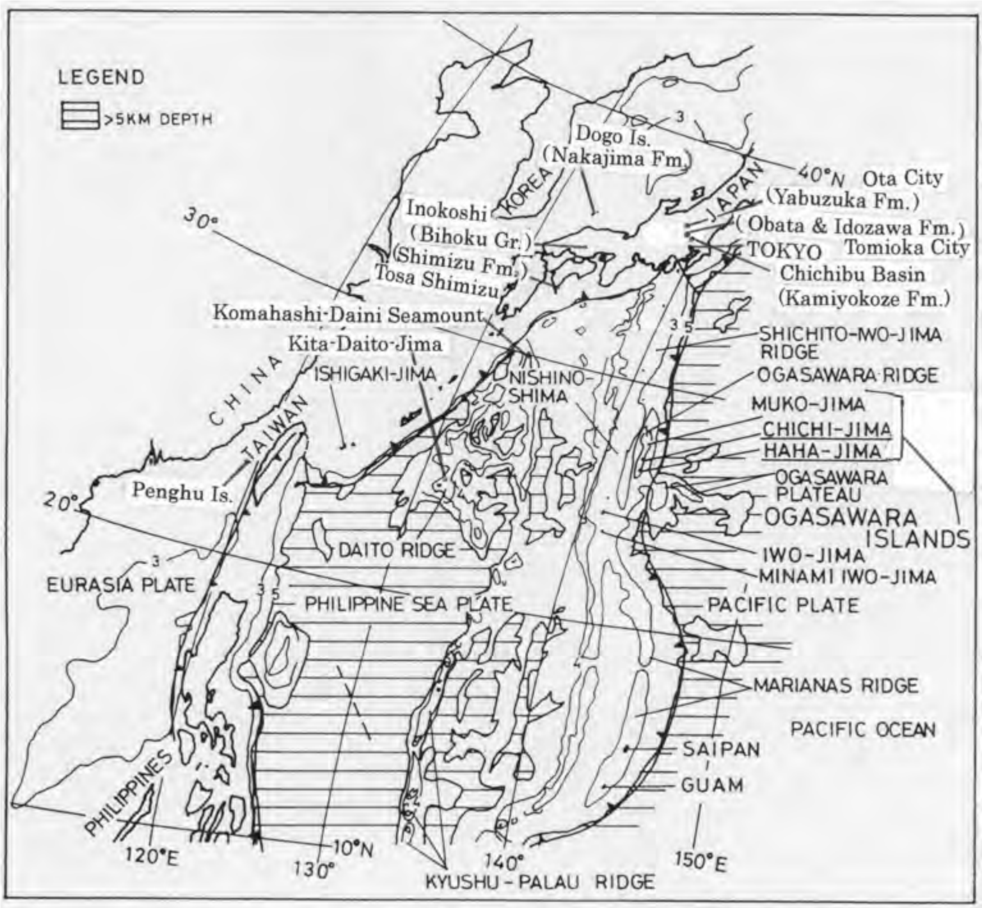

Fig. 5. Geographical locations from Japan and Taiwan treated in this study (Retouch to Matsumaru, 1996, fig. 1).

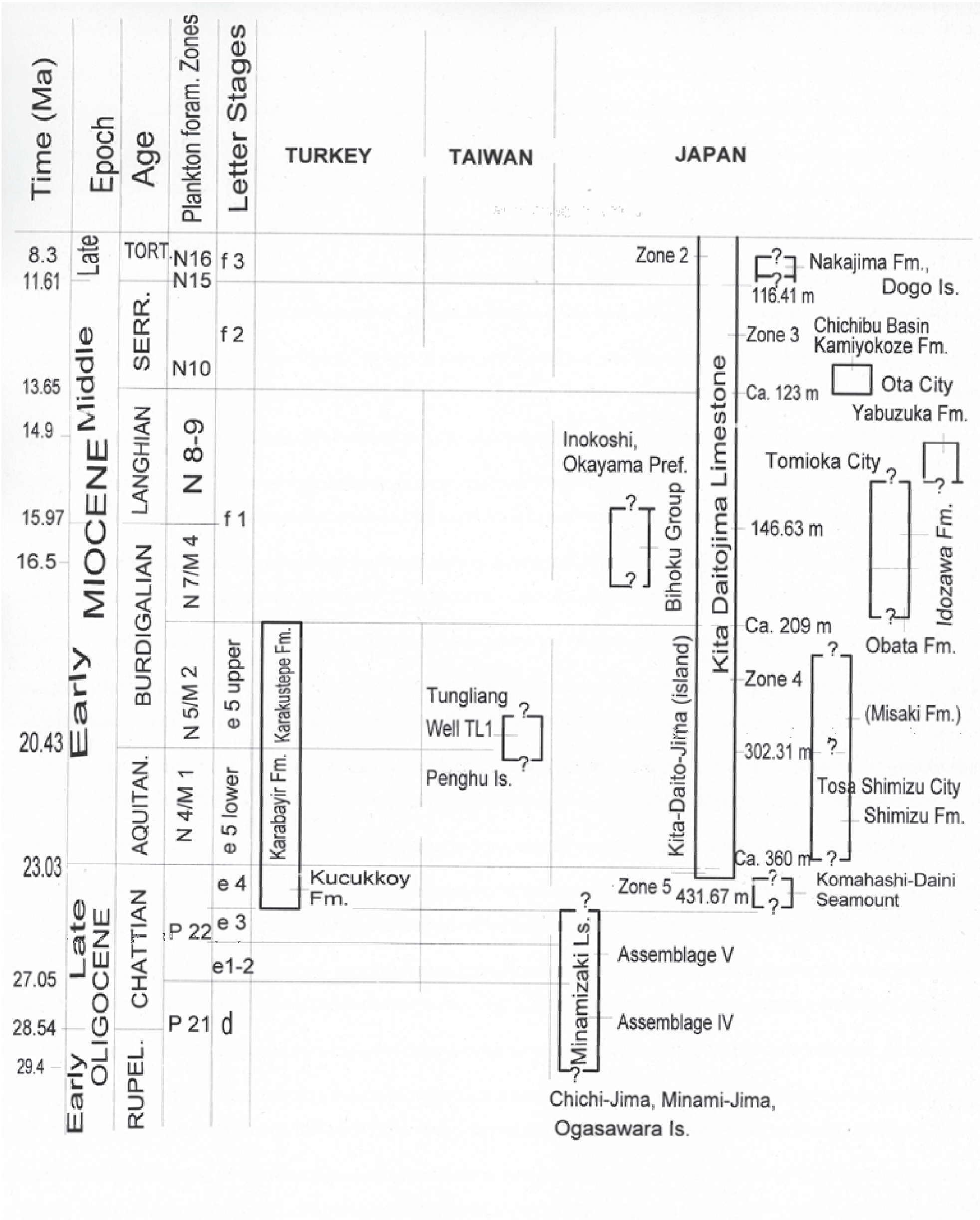

Fig. 6. Correlation chart between the stratigraphic columnar sections treated in Turkey (Matsumaru et al., 2010); Taiwan (Matsumaru, 1968); and Japan (Hanzawa, 1940; Matsumaru, 1967, 1971, 1972, 1977, 1980, 1982, 1996; Matsumaru et al., 1993; Mohiuddin et al., 2000; Nomura et al., 2003).

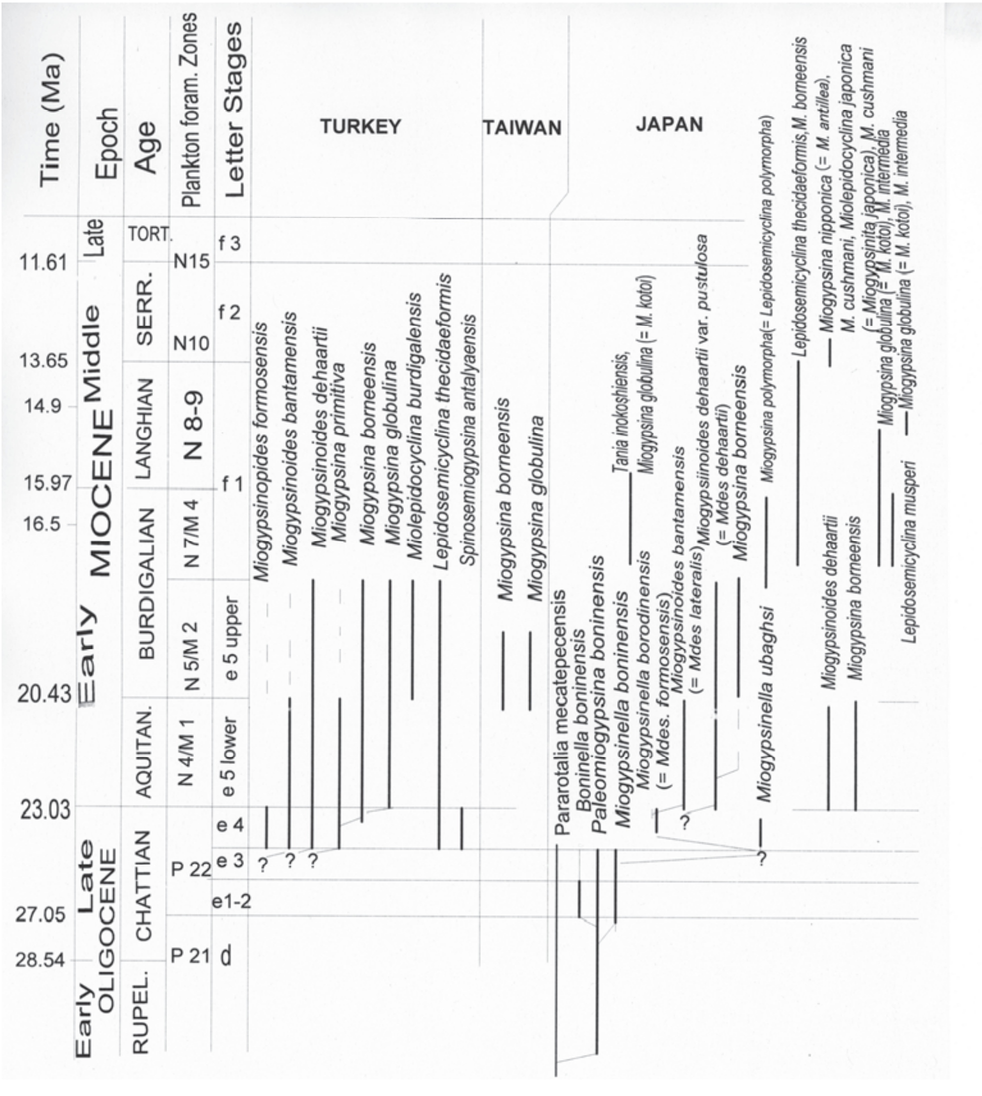

Fig. 7. Biostratigraphic occurrence of Miogypsinid foraminifera from Turkey, Taiwan and Japan.

3. Kita-Daito-Jima, Okinawa Prefecture, Japan

Five foraminiferal fauna have been established into depth zones of the drill cores (431.67-2.68 m thick) of the Kita Daitojima Limestone, at Kita-Daito-Jima (North Borodino Island, 25º56´47˝N. lat., 131º17´30˝E. long.), Okinawa Prefecture, Japan (Hanzawa, 1940) (Figures 4-7). Hanzawa's Zone 5 (431.67-394.98 m) is characterized by the occurrence of *Miogypsinella borodinensis* Hanzawa, which is later assigned to *Miogypsinoides borodinensis* (Hanzawa) without lateral chambers or with incipient lateral chambers by Hanzawa (1964). This species evolved from *Miogypsinoides formosensis* Yabe and Hanzawa (Hanzawa, 1964, p. 309, 311) due to decrease of number of nepionic chambers. In this study, *Miogypsinella borodinensis* of probable holotype specimen has the character of both number of nepionic chambers (X = 13) and A-P angle (AP = 220º) (Hanzawa, 1940, pl. 39, fig.6), and *Miogypsinoides formosensis* of probable holotype specimen has the character of both number of nepionic chambers (X = 16) and A-P angle (AP = 240º) (Yabe and Hanzawa, 1928, fig. 1a). Hanzawa's consideration is right, but there is unknown on species variation of both species. Both forms could fortunately be found from the Küçükkoy Formation in Korkuteli area, Bey Dağlari Autochton, Menderes-Taurus Platform, SW Turkey (Matsumartu et sl., 2010) (Figures 6-9). The author in Matsumaru et al. (2010) described *Miogypsinoides formosensis* (Yabe and Hanzawa) and regarded their all specimens of schizont (A1 form) and gamont (A2 form) of sexual reproduction, rather planispiral, and carrying rudimentary lateral chambers (Matsumaru et al., 2010, pl. 2, fig. 1) from the Küçükkoy Formation. A specimen (Matsumaru et al., 2010, pl. 1, fig. 8) has the character of number of nepionic chambers (X = 13) and A-P angle (AP = 210º), while a specimen (Matsumaru et al., 2010, pl. 1, fig. 9) has the character of number of nepionic chambers (X = 16) and A-P angle (AP = 250º). Another specimen (Matsumaru et al., 2010, pl. 1, fig. 10) has the character of number of nepionic chambers (X = 13) and A-P angle (AP = 260º). As such the Küçükkyoy Formation carrying *Miogypsinoides formosensis* was correlated with the Zone 5 drill cores (431.67-ca. 360 m, as stated below) of the Kita Daitojima Limestone due to occurrence of *Miogypsinella borodinensis* (= *Miogypsinoides formosensis*) (Matsumaru et al., 2010).

Sr isotope age of Hanzawa's Zone 5 is regarded as 24.3 to 23.5 Ma (Ohde and Elderfield, 1992), and then Hanzawa's Zone 5 is applied for drill cores from 431.67 to ca. 360 m from their age assignment (Figures 6-7). Judging from the Tan Sin Hok's nepionic acceleration, *Miogypsinella ubaghsi* occurred from the limestone of Komahashi-Daini Seamount evolved into *Miogypsinella borodinensis* (= *Miogypsinopides formosensis*) occurred from Zone 5 drill cores of Kita Daitojima Limestone due to reduction of number of nepionic chambers and low value of A-P angle (Figure 7).

4. Tosa-Shimizu City, Shikoku, Japan

The Shimizu Formation, Ashizuri Cape, Tosa Shimizu City, Shikoku, Japan occupies the southernmost part of the Shimanto Belt, one of Japanese Tectonic Zones, and consists of calcareous sandstone and volcanic conglomerate into the coherent rock facies and chaotic rock facies (Figures 5-7). The calcareous sandstone of the Shimizu Formation occurred *Miogypsinoides dehaartii* (van der Vlerk) (Plate 2, figure 12), *Miogypsina* sp, which is assigned to *M. borneensis, Nephrolepidina praejaponica* Matsumaru, *Spiroclypeus margaritatu*s (Schlumberger) and *Victoriella conoidea* (Rutten) in the location of Ashizuri Cape, Tosa Shimizu City, Kochi Prefecture, Japan (32º47´15.4 ˝N. lat., 132º57´34.6˝E. long., Matsumaru et al., 1993). The Misaki Formation of Tosa Shimizu City is composed on alternation of sandstone and mudstone, and crops out in 4 km NW of Ashizuri Cape and there is no contact with the Shimizu Formation. The lower member of the Misaki Formation occurs *Nephrolepidina praejaponica* Matsumaru, *Amphistegina radiata* (Fichtel and Moll), *Sphaerogypsina globulus* (Reuss) and *Rotalia* spp. and also occurrs planktonic foraminifera such as *Catapsydrax stainforthi* Bolli, *Globigerina altiapertura* Bolli, *G. immaturus* Leroy, *G. subquadratus* Brönnimann, *Globorotalia zealandica* Hornibrook, *Globorotaloides suteri* Bolli and *Praeorbulina sicana* (de Stefani) (Matsumaru and Kimura, 1989). At least *Nephrolepidina praejaponica*-bearing Misaki Formation is assumed to be correlated with Zone N5 to lower Zone N7 of planktonic foraminiferal Zonations (Blow, 1969). Therefore the *Miogypsinoides dehaartii* and *Miogypsina borneensis* bearing Shimizu Formation is underlain the Misaki Formation, and its age is regarded as Zone N4 or Zone N 5? (Blow, 1969) (Figures 6-7). Both embryonic and nepionic stages of *Miogypsinoides dehaartii* and *Miogypsina borneensis* from the Shimizu Formation are insufficient in oblique and vertical sections. The Shimizu Formation carrying *Miogypsinoides dehaartii* and *Miogypsina borneensis* may mostly be correlated with the upper Zone 4 drill cores (302.31 to ca, 209 m thick) of the Kita Daitojima Limestone due to the upper occurrence of *Miogypsinoides dehaartii* var. *pustulosa* (= *M. dehaartii,* s. l.) and *Miogypsina borneensis*, and without *Miogypsinoides bantamensis* (Hanzawa, 1940) (Figures 4-7). *Miogypsinoides dehaartii* s. l. of the Kita Daitojima Limestone has the character of number of nepionic chambers (X = 7, 7 and 7) and A-P angle (AP = 20^o, 10^o and 20^o) in three specimens (Hanzawa, 1940, pl. 40, figs. 29, 27 and 26), and *Miogypsina borneensis* of the Kita Daitojima Limestone has the character of number of nepionic chambers (X = 7 and 7) and A-P angle (AP = 10^o and 30^o) in two specimens (Hanzawa, 1940, pl. 41, figs. 19-20). However *Miogypsinoides bantamensis* (Tan Sin Hok) in the lower Zone 4 drill cores (ca. 360 to 302.31 m thick) has the character of number of nepionic chambers (X = 12, 12 and 13) in three specimens and A-P angle (AP = 165^o, 180^o and 195^o) (Hanzawa, 1040, pl. 39, figs. 16-17, 19). Then *Miogypsinoides bantamensis* evolved into *Miogypsinoides dehaartii* s. l. due to biostratigraphic occurrence and Tan Sin Hok's nepionic acceleration, with reduction of number of nepionic chambers as explained above (Figure 7). Moreover *Miogypsinoides dehaartii* without lateral chambers evolved into *Miogypsina borneensis* with lateral chambers (Figure 7).

5. Tungliang Well TL1, Paisa Island, Penghu Islands, Taiwan

Miogypsina globulina (B form, but not microspheric form; Matsumaru, 1968, pl. 36, figs. 1-6) with nepionic chambers arranged single type (= *Miogypsina borneensis* Tan Sin Hok) and *Miogypsina globulina* (A form; Matsumaru, 1968, pl. 35, figs. 1-6) with two unequal protoconchal nepionic spirals (= *Miogypsina globulina* (Michelotti)) have been found in *Miogypsina* bearing calcareous sandstone at about 500 m depth in the Tungliang Well TL1, located at about 800 m NE of Tungliang Village, Paisa Island, Penghu Islands, Taiwan (Figure 5). *Miogypsina borneensis* has the character of number of nepionic chambers (X = 6, 5, 6, 6, 7, and 6; mean X = 6) in 6 specimens (n = 6) and A-P angle (AP = 10^o, 15^o, 6^o, 6^o, 15^o and 25^o) (Matsumaru, 1968, pl. 36, figs. 1-6). *Miogypsina globulina* has the characters of ratio of two nepionic spirals (V = 32.56, 18.18, 15.20 and 28.36; mean V = 23.58) in 4 specimens (n = 4) (Matsumaru, 1968, pl. 35, figs. 1-4). Therefore the *Miogypsina* bearing sandstone of Well TL1, carrying *Miogypsina borneensis* and *M. globulina*, but not *Miogypsinoides dehaartii*, is stratigraphically younger than the Shimizu Formation and upper Zone 4 of the Kita Daitojima Limestone, which carry *Miogypsinoides dehaartii* and *Miogypsina borneensis* (Figures 6-7). As such *Miogypsina borneensis* carrying number of nepionic chambers (mean X = 6) from the *Miogypsina* sandstone, Well TL1, Paisa Island, Penghu Islands is necessarily fewer number of nepionic chambers than *M. borneensis* carrying number of nepionic chambers (mean X = 7) from the upper Zone 4 drill cores of Kita Daitojima Limestone, Kita-Daito-Jima.

6. Early to Middle Miocene *Miogypsina* from Honshu, Japan

The Obata and Idozawa Formations, Tomioka Group, Honshu, Central Japan are known as representative sedimentary rocks of late Early to early Middle Miocene age in Japan (Matsumaru, 1967, 1977) (Figures 5-7). Japanese *Miogypsina* has been known to occur from the Lower/Middle Miocene sedimentary rocks in Honshu, Japan as *Miogypsina kotoi* Hanzawa, 1931, *Miolepidocyclina* (= *Miogypsinita*) *japonica* Matsumaru, 1972, *Miogypsina japonica* Ujiie, 1973 (= *M. globulina* (Michelotti)), *M. nipponica* Matsumaru, 1980 (= *M. antillea* (Cushman) and *M. cushmani* Vaughan steps of nepionic acceleration), and *Tania inokoshiensis* Matsumaru, 1990, in addition to *Miogypsina borneensi*s Tan Sin Hok, *Lepidosemicyclina thecidaeformis* (Rutten), and *Lepidosemicyclina musperi* (Tan Sin Hok) (Plates 1-2). According to Matsumaru and Takahashi (2004), Japanese *Miogypsina* is discussed as the followings: The measurement data of topotype specimen of *Miogypsina kotoi* Hanzawa is as follows: V = 20, DI = 120 x 70 micron, DII/DI = 1.0, and $\gamma = 35^o$, and *Miogypsina kotoi* Hanzawa is junior synonym of *Miogypsina globulina* (Michelotti). *Miogypsina japonica* Ujiie from type locality and other three stations has the following data: V = 40.9 and DII/DI = 1.34, V = 39.2 and DII/DI = 1.28, V = 36.1 and DII/DI = 1.32, and V = 47.2 and DII/DI = 1.24. Then *Miogypsina japonica* Ujiie doesn't represent *Miogypsina cushmani* Vaughan, 1924 of V scale of Drooger (1963), but represent *M. globulina* due to having of V value (mean V = 40.85) (n = 4). The *Miogypsina* population at Nogami locality found from the Obata Formation, Tomioka Group, Tomioka City, Gunma Prefecture is known as V value (mean V = 43.93 in 20 specimens), which is assigned to *Miogypsina globulina* (Matsumaru, 1967, 1977) (Figures 5-6). However, critical viewing Miogypsinid population, *Lepidosemicyclina musperi* (Rutten) and *Miogypsina cushmani* Vaughan with V value (V = 77) can be found from the Obata Formation (Figure 7). The Obata Formation is conformably overlain by the basal tuff (T6 Tuff or Wagoubashi Tuff, Matsumaru, 1967) of the Idozawa Formation carrying *Miogypsina globulina,* and the fission truck age of the T6 Tuff is 16. 5 ± 1.9 Ma by Nomura and Ohira (1998). The Idozawa Formation is conformably overlain by the basal tuff (T5 Tuff, Matsumaru, 1967) of the Haratajino Formation, which yields *Orbulina suturalis* Brönnimann, *O. universa* d'Orbigny, *Globorotalia birnagea* Blow, *Globigerinoides sicanus* de Stefani and others (Matsumaru, 1977). The fision truck age of T5 Tuff is 15.2 ± 0.5 Ma (Nomura and Ohira, 2002). Then the geological age of the Idozawa Formation is roughly Langhian of early Middle Miocene based on Zone N8 (Blow, 1969; Berggren et al., 1995), and the age of T5 Tuff is regarded to be the age of the *Orbulina* datum-plane. The *Miogypsina* population at Kanayama locality found from the Yabuzuka Formation at Ota City, Gunma Prefecture is known as V value (mean V = 47.38 in 24 specimens), which is assigned to *Miogypsina intermedia* of Drooger's mean V scale (Figures 5-7). The Kanayama *Miogypsina* population is found from the medium sandstone below the pumice tuff of the Yabuzuka Formation, and fission truck age of this tuff is 14.9 ± 0.5 Ma (Nomura et al., 2003). As such Miogypsinid foraminifera from the Obata, Idozawa and Yabuzuka Formations are known as *Miogypsina globulina* (Michelotti) and *Miogypsina intermedia* Drooger Assemblage. Raju (1974) and Mishra (1996) regarded *Miogypsine globulina* as population with mean V value between zero and 45 and positive γ, but *Miogypsina intermedia* couldn't find from the study of Indian *Miogypsina*. These criteria are arbitrary, and why they cannot find *Miogypsina intermedia* between *Miogypsina globulina* and *Miogypsina cushmani* or *M. antillea* in a series of mean V value scale? (Figure 7).

Miogypsina nipponica Matsumaru is found from the middle member of the Kamiyokoze Formation, at sample location UN-1 (35º58´31˝ N. lat., 139º5´42˝E. long.), Chichibu Basin, Saitama Prefecture (Matsumaru, 1980) (Figures 5-6). Also the planktonic foraminifera such as *Globigerinoides immaturus* (Leroy), *Globigerinoides subquadratus* Brönnimann, *Globigerina praebulloides* Blow, *Globorotalia* (*Turborotalia*) *peripheroacuta* Blow and Banner, and *Globorotalia* (*Turborotalia*) *birnagea* Blow are found from the upper member of the Kamiyokoze Formation at sample location NG-1 (35º58´25˝ N. lat., 139º6´20˝ E. long.), Chichibu Basin, and these fauna is shown in the lower part of Zone N10 of Blow (1969) (Matsumaru, 1980). *Miogypsina nipponica* has the character of V value in 23 specimens (mean V = 88.38 ±5.20) and this mean V value is regarded as *Miogypsina antillea* (Cushman) step of Drooger (1952). V value of *Miogypsina nipponica* varies from 78 to 100, and more than 42 % of specimens having V value larger than 90. Then *Miogypsina nipponica* Matsumaru has both V value of *Miogypsina cushmani* (Cushman) step and *M. antillea* step of Drooger (1952). Raju (1974) regarded *Miogypsina cushmani* as miogypsinid population with mean V value between 70 and 100, usually less than 90, and more than 50 % carrying less than 90. Also *Miogypsina antillea* has mean V value between 70 and 100, and more than 50 % carrying greater than 90.

Miogypsina nipponica resembles the topotype of *Miogypsina antillea* according to Cole (1957, pl. 29, fig. 1), but *M. nipponica* frequently possess small nepionic chambers on the deuteroconch (Matsumaru, 1980, pl. 25, figs. 4-5) (Plate 1, figure 10). The ogival to lozengic equatorial chambers and very short hexagonal equatorial chambers are sometimes distributed in *Miogypsina nipponica*, but the elongate hexagonal equatorial chambers are distributed in the frontal margins in *Miogypsina antillea* by Raju (1974, pl. 2, figs. 25-26). *Miogypsina nipponica* is distinguished from *Miogypsina antillea* by Frost and Langenheim (1974) in view of the description and illustration of Mexican specimens. In this study, *Miogypsina nipponica* is regarded as *Miogypsina antillea* step of V value, and associated with *Miogypsina cushmani* Vaughan and *Miolepidocyclina* (= *Miogypsinita*) *japonica* Matsumaru (Figure 7).

Miogypsina kotoi, which is junior synonym of *Miogypsina globulina*, is found from the Nakajima Formation, Dogo Island, Oki Islands (Matsumaru, 1982) (Figures 5-6). The sample location is Kumi at left side of the Kumi River about 1.1 km NW of Kumi Tunnel, Goka-Mura (village), Oki-Gun, Shimane Prefecture, Japan (36º18´11˝ N. lat., 133º15´5˝ E. long.). *Miogypsina kotoi* has the character of V value of 34 specimens (mean V = 31.29 ± 11.0), and is in association with planktonic foraminifera such as *Globorotalia acostaensis acostaensis* Blow, *G. continuosa* Blow, *G. quinifalcata* Saito and Maiya, *G. scitula* (Brady), *Globigerinoides quadrilobaturus* Leroy and *Globigerina* sp. Then the geological age of the Nakajima Formation carrying *Miogypsina kotoi* is early Late Miocene based on Zone N16 (Blow, 1969). Therefore it is inferred from the planktonic foraminiferal zones that *Miogypsina kotoi* with low mean V value from the Nakajima Formation were reworked from the pre-Nakajima Formation. Moreover *Miogypsina kotoi* (= *M. globulina*) from the Nakajima Formation is associated with *Miogypsina borneensis* Tan Sin Hok, which is known to occur from the Lower/Middle Miocene sedimentary rocks in Japan in the Yatsuo Formation, Toyama Prefecture; and Hirashio Formation, Ibaraki Prefecture (Matsumaru and Takahashi, 2004).

Tania inokoshiensis Matsumaru is found from the sandstone of the Lower Formation (“Yamaga” Formation) of the Bihoku Group, Okayama prefecture (Matsumaru, 1990) (Figures 2, 5-7). The sample location is the same place as Hanzawa’s (1935) and Tan Sin Hok’s (1937) Inokoshi, Koyamaichi Village, Kawakami-Gun, Okayama Prefecture (34º45´ N. lat., 133º24´ E. long.) (Figures 5-6). *Tania inokoshiensis* Matsumaru is characterized by having

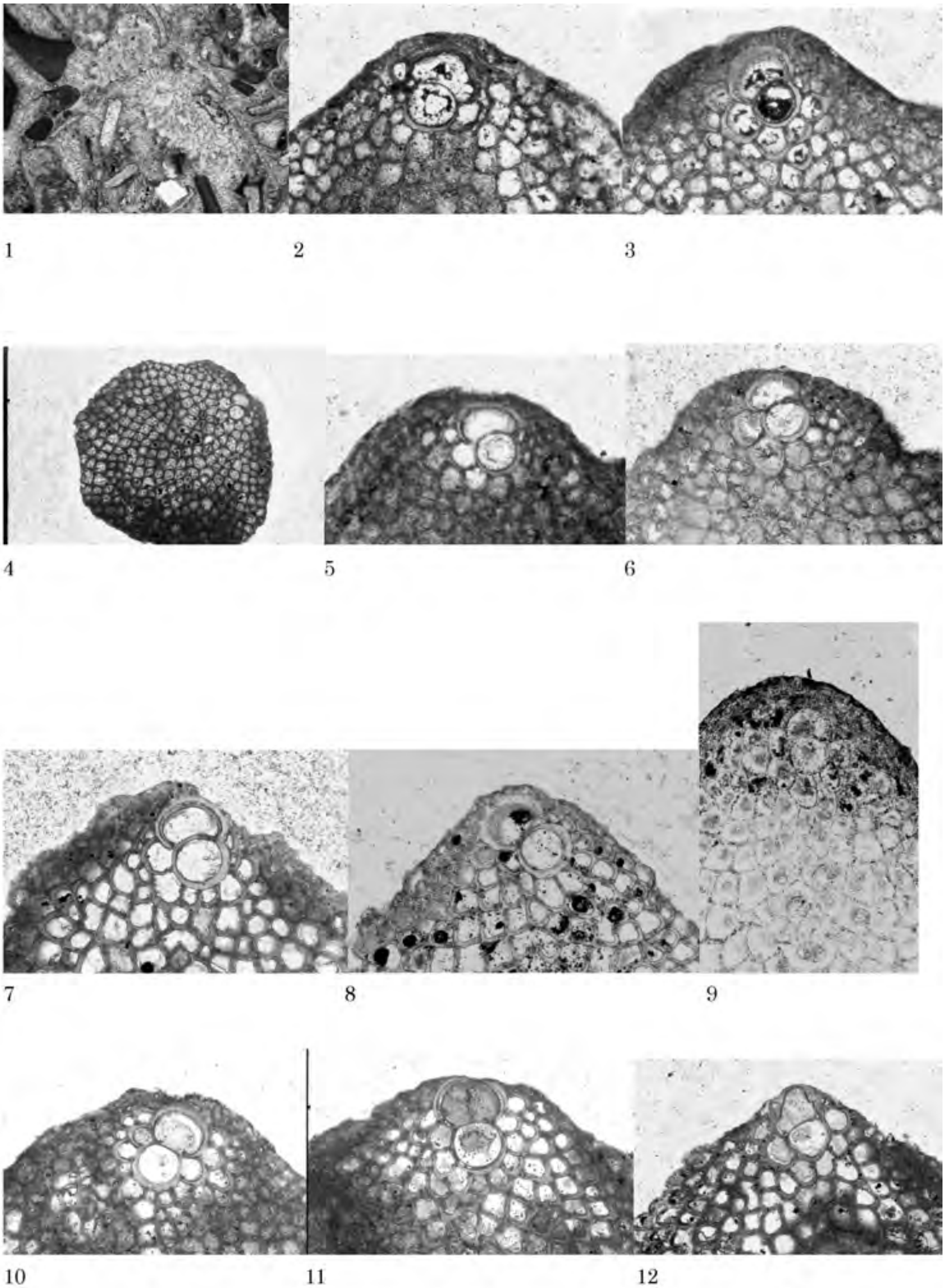

Plate 1.
Figures 1-5. *Miogypsina globulina* (Michelotti)
1. Centered oblique section. Topotype specimen of *Miogypsina kotoi* Hanzawa, 1931.

Otsuki Limestone at Otsuki locality, Yamanashi Prefecture, Japan. x 19. 2-5. Equatorial sections. 2-3, 5. Miyato Formation, correlated with Obata Formation, at Komori locality, Saitama Prefecture, Japan, x 53. 2: V = 25, $\gamma = 20^o$. 3; V = 29, $\gamma = 25^o$; 5: V = 40, $\gamma = 20^o$; 4. Shiomizaki Formation at Todoroki locality, Aomori Prefecture, Japan. x 19. V = 35, $\gamma = 35^o$.
Figures 6-8. *Miogypsina intermedia* Drooger.
Equatorial sections. 6-7. Ichinokawa Formation, correlated with Idozawa Formation, at Kawabata locality, Saitama Prefecture, Japan. x 53. 6: V = 46, $\gamma = 25^o$; 7: V = 48, $\gamma = 20^o$. 8. Nakahara Formation at Hota locality, Chiba Prefecture, Japan. x 53. V = 62, $\gamma = 40^o$.
Figure 9. *Miogypsina cushmani* Vaughan
Equatorial section. Yabuzuka Formation, correlated with Idozawa and/or Haratajino Formations, at Kanayama locality, Gunma Prefecture, Japan. x 53. V = 70, $\gamma = 10^o$.
Figures 10-12. *Miogypsina nipponica* Matsumaru
Equatorial sections. 10-12. Kamiyokoze Formation, at Une locality, Saitama Prefecture, Japan. x 53. 10. V = 84, $\gamma = 30^o$ (This specimen possess *Miogypsina cushmani* step of V value, and small nepionic spirals on the outer wall of deuteroconch). 11. Holotype, Saitama Univ. coll. no. 800301, V = 93, $\gamma = 5^o$; 12. V = 90, $\gamma = 20^o$.

the peculiar structure of two unequal sets of spiral nepionic chambers, situated along the outer wall of deuteroconch, but not outer wall of protoconch, and having lozengic and short hexagonal shaped equatorial chambers and rectangular shaped lateral chambers (Plate 2, figures 8-9). Then *Tania inokoshiensis* represents more primitive arrangement of embryonic chambers and more advanced hexagonal equatorial chambers than each one of *Miogypsina globulina*, and is associated with *Miogypsina globulina*, which carry the character of V value (mean V = 44.31 in 37 specimens) at Inokoshi (Matsumaru and Takahashi, 2004). *Tania inokoshiensis* is similar to *Lepidosemicyclina thecidaeformis* due to having short hexagonal shaped equatorial chambers. But *Tania inokoshiensis* is different from *Lepidosemicyclina thecidaeformis* in having characteristic structure of two sets of spiral nepionic chambers developed along the outer wall of deuteroconch, but not along the outer wall of protoconch. *Tania inokoshiensis* is similar to *Miogypsina primitiva* Tan Sin Hok due to having deuteroconch situated on the frontal side of test and/or situated beside protoconch along the outer wall of protoconch. However*Tania inokoshiensis* is different from *Miogypsona primitiva* in having two sets of nepionic spirals along the outer wall of deuteroconch. The *Miogypsina* Sandstone of the Lower Formation, Bihoku Group is correlated with the Obata and Idozawa Formations, Tomioka Group due to similar mean value of parameter V of *Miogypsina globulina*. Moreover the *Miogypsina* Sandstone of the Lower Formation, Bihoku Group occurs *Miolepidocyclina japonica* Matsumaru, and is at lest correlated with the lower Zone 3 drill cores (ca. 209-146.63 m) of the Kita Daitojima Limestone due to occurrence of *Miogypsina* (= *Lepidosemicyclina*) *polymorpha* (Rutten) with hexagonal equatorial chambers (Hanzawa, 1940) (Figures 6-7). *Miolepidocyclina japonica* is known to occur from the Lower/Middle Miocene Yatsuo Formation, Toyama Prefecture; Shiomizaki Formation, Aomori Prefecture; Saigo Formation, Shizuoka Prefecture; Naeshiroda Formation, Ibaraki Prefecture; Gassanzawa Sandstone, Yamagata Prefecture; Saginosu Formation, Saitama Prefecture; and Nakahara Formation, Chiba Prefecture, respectively. Their locations are shown in Honshu, Japan (Matsumaru and Takahashi, 2000, fig. 1).

7. Korkuteli Area, Bey Dağlari Autochton, Menderes - Taurus Platform, Turkey

The Oligocene - Miocene succession of the Küçükkoy, Karabayir and Karakuştepe Formations is known to occur in the Bey Dağlari Autochton in the Menderes - Taurus Platform of main

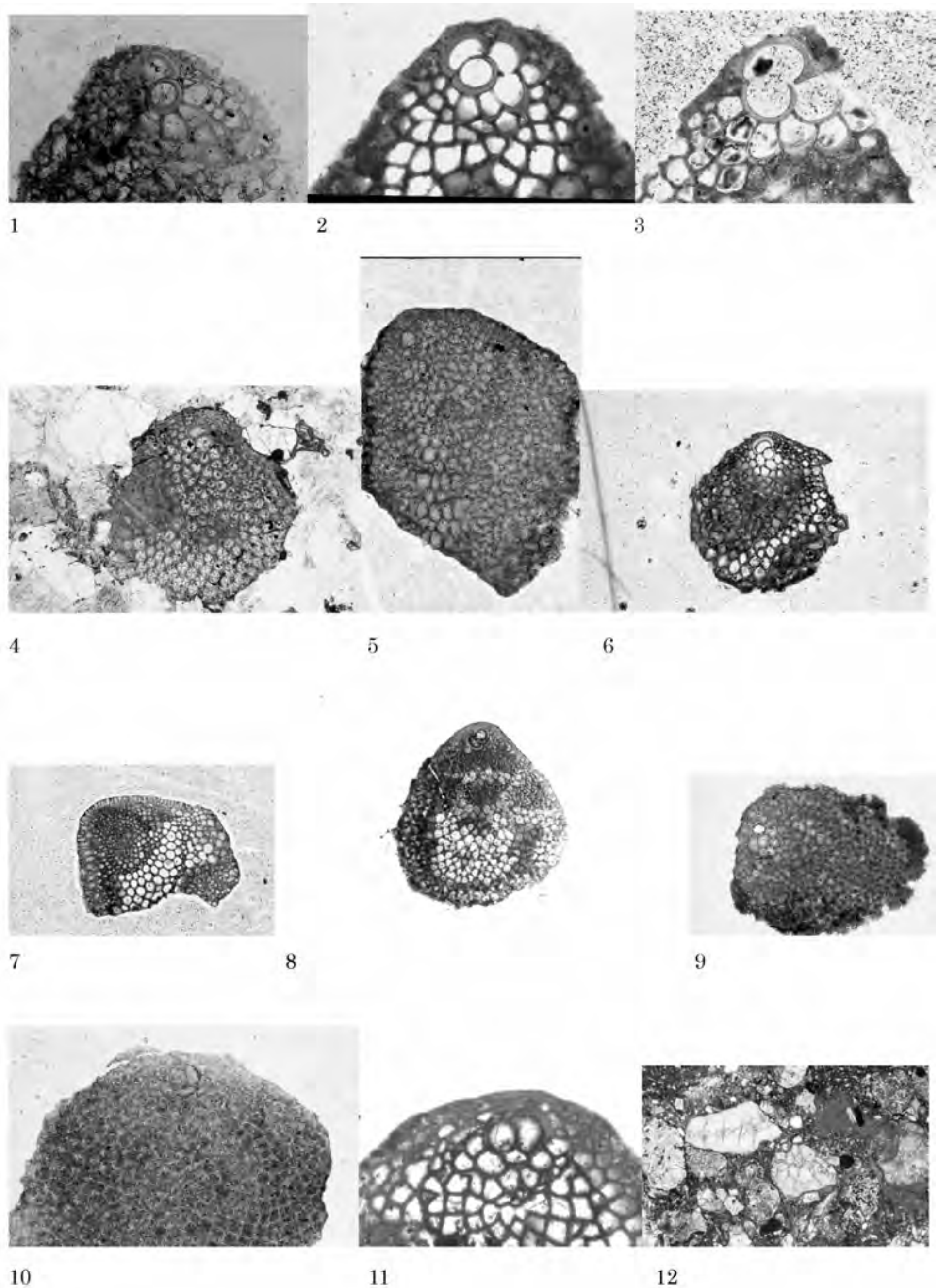

Plate 2.
Figures 1-3. *Miogypsina borneensis* Tan Sin Hok

Equatorial sections. 1. Naeshiroda Formation at Tsukiori-Toge locality, Ibaraki Prefecture, Japan. x = 6, $\gamma = 25^o$; 2. Nakajima Formation at Dogo locality, Shimane prefecture, Japan. x = 6, $\gamma = -30^o$; 3. Hirashio Formation at Tanagura locality, Ibaraki Prefecture, Japan. x = 6, $\gamma = 20^o$. x 53.
Figure 4. *Lepidosemicyclina musperi* (Tan Sin Hok)
Equatorial section. Obata Formation at Nogami locality, Gunma Prefecture, Japan. x 19.
Figures 5-7. *Lepidosemicyclina thecidaeformis* Rutten
Equatorial sections. 5-6. Megalospheric specimens, 5. Koguchi Formation at Kushimoto, Wakayama Prefecture, Japan, 6. Nakahara Formation at Hota locality, Chiba Prefecture, Japan. 7. Microspheric specimen. Nakahara Formation at Hota locality, Chiba prefecture, Japan. x 19.
Figures 8-9. *Tania inokoshiensis* Matsumaru
Equatorial sections. 8-9. Lower ("Yamaga") Formation, Bihoku Group, at Inokoshi, Okayama Prefecture, Japan. 8. Holotype, Saitama Univ. coll. no. 8803. x 19.
Figures 10-11. *Miolepidocyclina japonica* Matsumaru
Equatorial sections. 10. Gassanzawa Sandstone at Gassanzawa, Yamagata Prefecture, Japan. Holotype, Saitama Univ. coll. no. 720301. 11. Saigo Formation at Shinzaike locality, Shizuoka Prefecture, Japan. 10. x 19, 11. x 53.
Figure 12. *Miogypsinoides dehaartii* (van der Vlerk)
12 left. Axial section. 12 right. Oblique section. Shimizu Formation at Ashizuri Cape, Kochi Prefecture, Japan. x 19.

tectonic units, 40 km NW Antalya City, Turkey (Figure 8). 13 columnar sections from Korkuteli to Karabayir Villages in Korkuteri area, Bey Dağlari Autochton are examined for Miogypsinid biostratigraphy (Matsumaru et al., 2010, figs. 1-3). As results, three larger foraminiferal assemblages are established as the following: *Miogypsinoides formosensis - Miogypsinoides bantamensis - Miogypsinoides dehaartii - Miogypsina primitiva - Spiroclypeus margaritatus* Assemblage (Assemblage 1), *Miogypsinoides bantamensis - Miogypsinoides dehaartii - Miogypsina primitiva - Miogypsina borneensis – Miogypsina globulina – Spiroclypeus margaritatus* Assemblage (Assemblage 2), and *Miogypsinoides dehaartii – Miogypsina borneensis – Miogypsina globulina – Miolepidocyclina burdigalensis* Assemblage (Assemblage 3). The Assemblage 1 is known from the Küçükkoy Formation, and 7 species of *Miogypsinoides formosensis, Miogypsinoides bantamensis, Miogypsinoides dehaartii, Miogypsina primitiva Miogypsina borneensis, Lepidosemicyclina thecidaeformis*, and *Spinosemiogypsina antalyaensis* Matsumaru, Özer and Sari are found in this Assemblage 1 (Figure 7). However two species of *Paleomiogypsina boninensis* Matsumaru and *Miogypsinella complanata* (Schlumberger) in the Assemblage 1 are considered to be reworked. The Assemblage 1 is a younger assemblage than *Miogypsinella boninensis – Spiroclypeus margaritatus – Austrotrillina howchini* Assemblage (Assemblage V) from the upper Minamizaki Limestone, Ogasawara Islands, Japan (Matsumaru, 1996). Because the Ogasawara assemblage (V) has the occurrence of *Miogypsinella boninensis* carrying primitive nepionic spirals and probable planktonic foraminifera belonging to Zone P22 than Zone P21 of Blow (1969) (Matsumaru, 1996) (Figures 6-7). Moreover the Assemblage 1 of Turkey is correlated with Zone 5 drill cores (431.67-ca.360 m) of the Kita Daitojima Limestone (Hanzawa, 1940) due to occurrence of *Miogypsinella borodinensis* (= *Miogypsinoides formosensis*) (Matsumaru et al., 2010). The measurement data of Miogypsinid foraminifera in the Assemblage 1 is as follows: A schizont specimen (A1 form; DI = 88 x 92 micron, DII = 96 x 40 micron)) of *Miogypsinoides* *formosensis* (Matsumaru et al., 2010, pl. 1, fig. 8) from locality 97-95 in Section 7 has the character of number of nepionic chambers (X = 13) and A-P angle (AP = 210º), while a schizont specimen (DI = 88 x 96 micron, DII = 96 x 48 micron) of *Miogypsinoides formosensis* (Matsumaru et al., 2010, pl. 1, fig. 9) from locality 97-96 in Section 7 has the character of number of nepionic chambers (X = 16) and A-P angle (AP = 250º). A gamont specimen (A2 form; DI = 160 x 160 micron, DII = 128 x 48 micron) of *Miogypsinoides formosensis* (Matsumaru e al., 2010, pl. 1, fig. 10) from locality 96-136 in Section 11 has the character of nepionic chambers (X = 13) and A-P angle (AP = 260º), and also a schizont specimen (DI = 104 x 112 micron, DII = 84 x 44 micron) of *Miogypsinoides bantamensis* (Matsumaru et al., 2010, pl. 2, fig. 3) from locality 97-95 in Section 7, in associated with *Miogypsinoides formosensis*, has the character of number of nepionic chambers (X = 13) and A-P angle (AP = 180º). A gamont specimen (DI = 184 x 168 micron, DII = 192 x 136 micron) of *Miogypsinoides bantamensis* (Matsumaru et al., 2010, pl. 2, fig. 4) from locality 96-137 in Section 11, associated with *Miogypsinoides formosensis*, has the character of number of nepionic chambers (X = 11) and A-P angle (AP = 150º). A gamont specimen (DI = 136 x 120 micron, DII = 128 x 80 micron) of *Miogypsinoides bantamensis* (Matsumaru et al., 2010, pl. 2, fig. 5) from locality 96-137 in Section 11 has the character of number of nepionic chambers (X = 10) and A-P angle (AP = 150º). Moreover on *Miogypsinoides dehaartii*, associated with *Miogypsinoides formosensis* and *Miogypsinoides bantamensis*, a gamont specimen (DI = 152 x 116 micron, DII = 168 x 88 micron; Matsumaru et al., 2010, pl. 2, fig. 7) from locality 97-95 in Section 7 has the character of number of nepionic chambers (X = 9) and A-P angle (AP = 60º), while a gamont specimen (DI = 176 x 168 micron, DII = 208 x 160 micron; Matsumaru et al., 2010, pl. 2, fig. 8) from locality 96-119 in Section5 has the character of nepionic chambers (X = 7) and A-P angle (AP = 50º). A gamont specimen (DI = 224 x 200 micron, DII = 244 x 112 micron; Matsumaru et al., 2010, pl. 3, fig. 6) from locality 97-95 in Section 7 has the character of number of nepionic chambers (X = 10) and A-P angle (AP = 60º).

On *Miogypsina primitiva,* associated with *Miogypsinoides formosensis, Miogypsinoides bantamensis* and *Miogypsinoides dehaartii*, a schizont specimen (DI = 84 x 88 micron, DII = 72 x 56 micron) from locality 97-95 in Section 7 has the character of nepionic chambers (X = 12) and A-P angle (AP = obscure due to twist) (Matsumaru et al., 2010, pl. 3, fig. 4), while a gamont specimen (DI = 200 x 176 micron, DII = 176 x 128 micron) from locality 97-95 in Section 7 has the character of nepionic chambers (X = 10) and A-P angle (AP = 110º) (Matsumaru et al., 2010, pl. 3, fig. 5).

The Assemblage 2 is known from the Karabayir Formation, and 6 species of *Miogypsinoides bantamensis, Miogypsinoides dehaartii, Miogypsina primitiva, Miogypsina borneensis*, *Miogypsina globulina* and *Lepidosemicyclina thecidaeformis* are found from the Assemblage 2 (Figur 7). The Assemblage 2 is correlated with lower Zone 4 drill cores (ca. 360-302.31 m) of the Kita Daitojima Limestone (Hanzawa, 1940) due to occurrence of *Miogypsinoides bantamensis, Miogypsinoides lateralis*, and *Miogypsinoides dehaartii* var. *pustulosa* (= *M. dehaartii*) (Matsumaru et al., 2010). The measurement data of Miogypsinid foraminifera of the Assemblage 2 is described as follows: a schizont specimen (DI = 112 x 96 micron, DII = 120 x 72 micron) of *Miogypsinoides bantamensis* (Matsumaru et al., 2010, pl. 2, fig. 2) from locality 96-121 in Section 5 has the character of number of nepionic chambers (X = 12) and A-P angle (AP = 180º). On *Miogypsina primitiva*, two specimens are measured: a schizont specimen (DI = 96 x 72 micron, DII = 88 x 40 micron) from locality 97-90 in Section 8 has the character of nepinic chambers (X = 11) and A-P angle (AP = 145º) (Matsumaru, 2010, pl. 3, fig. 2), and a schizont specimen (DI = 96 x 90 micron, DII = 88 x 64 micron) from locality 97-153 in Section 4 has the character of nepionic chambers (X = 9) and A-P angle (AP = 110º) (Matsumaru et al., 2010, pl. 3, fig. 3). On *Miogypsiona borneensis*, three specimens are measured: a gamont specimen (DI = 120 x 112 micron, DII = 128 x 84 micron) from locality 97-90 in Section 8 has the character of nepionic chambers (X = 8) and A-P angle (AP = 50º) (Matsumaru et al., 2010, pl. 3, fig. 9). A gamont specimen (DI = 120 x 116, DII = 140 x 83 micron) from locality 97-152 in Section 4 has the character of nepionic chambers (X = 7) and A-P angle (AP = 25º) (Matsumaru et al., 2010, pl. 3, fig. 10), while a schizont specimen (DI = 96 x 72, DII = 88 x 40 micron) from locality 97-90 in Section 8 has the character of nepionic chambers (X = 7) and A-P angle (AP = 20º) (Matsumaru et al., 2010, pl. 4, fig. 1). Also a schizont specimen (DI = 128 x 104, DII = 144 x 80 micron) of *Miogypsina globulina* from locality 97-90 in Section 8 shows the character of V value (V = 30) and γ value (γ = 10º) (Matsumaru et al., 2010, pl. 4, fig. 7).

The Assemblage 3 is known from the Karakuştepe Formation, and 5 species of *Miogypsinoides dehaartii, Miogypsinopides borneensis, Miogypsina globulina, Miolepidocyclina burdigalensis* and *Lepidosemicyclina thecidaeformis* are found from the Assemblage 3 (Figure 7). The Assemblage 3 is correlated with upper Zone 4 drill cores (302.31 – ca. 209 m) of the Kita Daitojima Limestone (Hanzawa, 1940) due to occurrence of *Miogypsinoides dehaartii* var. *pustulosa* (= *M. dehaartii*) and *Miogypsina borneenisis* (Matsumaru et al., 2010). In the Assemblage 3, the following Miogypsinid foraminifera are measured: On *Miogypsina globulina*, two specimens are measured; a gamont specimen (DI = 200 x 136, DII = 216 x 120 micron) from locality 97-142 in Section 4 has the character of V value (V = 35) and γ value (γ = 40º) (Matsumaru et al., 2010, pl.4, fig. 5), and a gamont specimen (DI = 176 x 152, DII = 248 x 152 micron) from locality 97-125 in Section 4 has the character of V value (V = 25) and γ value (γ = 34º) (Matsumaru et al., 2010, pl. 4, fig. 6).

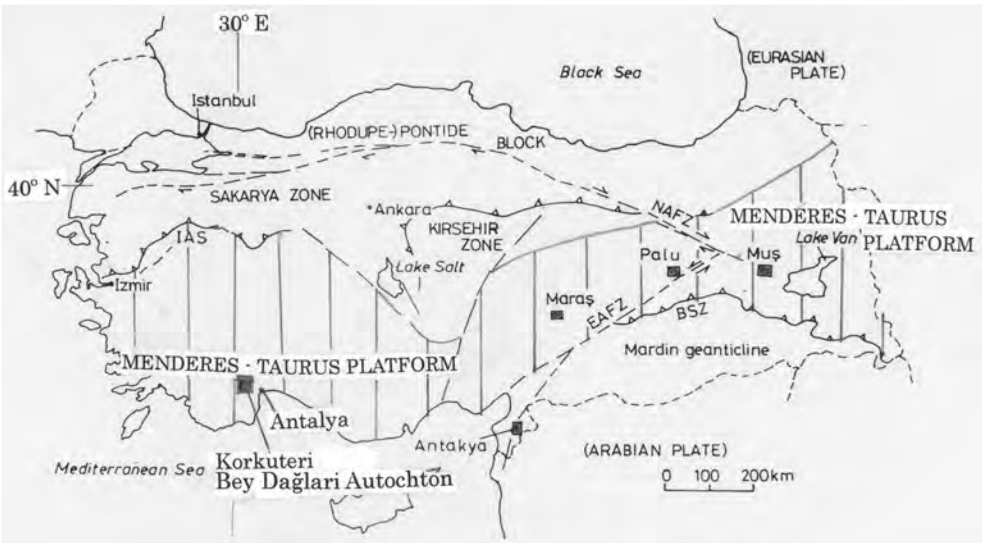

Fig. 8. Locations of research areas (Maraş Palu and Muş) in Turkey treated in this study, in addition to Korkuteri area (Matsumaru et al., 2010). Antakya area without Miogypsinid samples is described in the text.

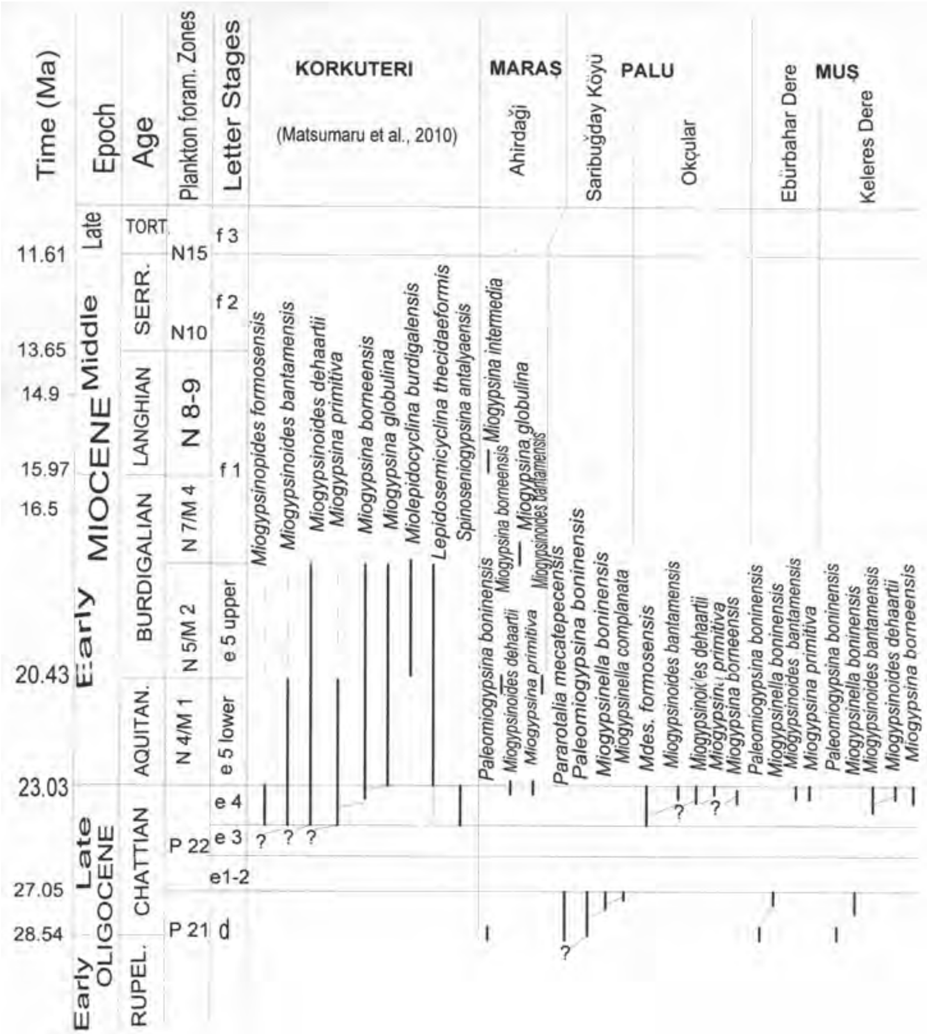

Fig. 9. Biostratigraphic occurrence of Miogypsinid foraminifera from Korkuteri, Maraş, Palu, and Muş areas in the Menderes – Taurus Platform, Turkey.

4. Biostratigraphic occurrence of Miogypsinid foraminifera from Maraş, Palu and Muş areas in the Menderes - Taurus Platform, Turkey

While the author has visited the General Directorate of Mineral Resaerch and Exploration (MTA; T.C. Maden Tetkik Ve Arma Genel Müdürlüğü), Ankara as the Japan Society for the Promotion of Science (JSPS) fellowship researcher for a half year in 1992, he has investigated the foraminifers from the upper Cretaceous to middle Miocene sedimentary rocks in Turkey. This study is to give a note on Miogypsinid foraminiferal Biostratigraphy of Maraş, Palu, and Muş Areas in the eastern Turkey after Uysal et al. (1985), except Antakya Area due to lack of

Miogypsinid foraminifera-bearing samples, where *Nummulites fabianii* (Prever), *N. perforatus* (Montfort), *Pellatispira orbitoidea* (Provale) and others are found from samples A-1 to A-8. Here the author describes useful scientific contribution for Miogypsinid foraminifera (Figures 8-9).

1. Ahirdaği Section, Maraş Area

According to Uysal et al (1985), there are four columnar sections in Maraş Area. In Ahirdaği section in this study, there are five Miogypsinid horizons. Basal samples 77/59 to 77/57 yield *Paleomiogypsina boninensis* Matsumaru, *Lepidocyclina boetonensis* van der Vlerk, carrying the character (DI = 300 x 188 micron, DII = 390 x 223 micron, and DI = 305 x 200 micron, DII = 335 x 215 micron, and thickness of embryonic wall (T = 12 micron)) in two specimens, *Nephrolepidina marginata* (Michelotti), *Heterostegina borneensis* van der Vlerk, carrying the character (1 or 2? operculine chamber(s) and 19 to 20 nepionic septa), and *Cycloclypeus koolhoveni* Tan Sin Hok, carrying the character (more than 23 and 25 heterostegine septa, and DI = 118 x 118 micron), and *Eulepidina dilatata* (Michelotti). They are regarded as the age of late Early to early Late Oligocene. Also they are assigned to probable Tertiary d of the Letter Satges (Leupold and van der Vlerk, 1931; Matsumaru, 1996), because of the occurrence of *Paleomiogypsina boninensis, Heterostegina borneensis,* and *Eulepidina ephippioides,* which are dominated in the Minamizaki Limestone, Ogasawara Islands, Japan (Matsumaru, 1996) (Figures 6-7). Moreover *Paleomiogypsina boninensis* in the Assemblage 1 was found in samples 97-486, 97-502, and 97-503 from the Küçükkoy Formation in the Korkuteri Area, Bey Dağlari Autochton, but *Paleomiogypsina boninensis* was regarded as the reworked species in those samples as stated before (Matsumaru et al., 2010, pl. 1, figs. 1-4) (Figure 9). Sample 77/60, 10 m below from Sample 77/59, yields *Eulepidina dilatata, Lepidocyclina boetonensis* van der Vlerk, carrying the character (DI = 320 x 220 micron, DII = 325 x 125 micron, and 6 nepionic spirals), *Nephrolepidina marginata,* and *Heterostegina borneensis*, carrying the character (1 operculine chambers, 8 chambers in 1 whorl, and 21 chambers in 2 whorls), although there is no Miogypsinid foraminifera, but it is worth to describe the fauna.

More than 40 m above from sample 77/57, sample E479 in Ahirdağgi Section yields *Miogypsinoides dehaartii* (van der Vlerk), carrying number of nepionic chambers (X = 7), *Miogypsina primitiva* Tan Sin Hok, carrying the character (X = 9), *Elphidium* spp., and *Planorbulinella larvata* (Parker and Jones). This horizon is probable assigned to the boundary between the Oligocene and Miocene, due to occurrence of *Miogypsinoides dehaartii* and *Miogypsina primitiva* based on foraminiferal biostratigraphic occurrences between the Küçükkoy and Karabayir Formations, Korkuteri Area (Matsumaru et al., 2010) (Figures 6-7, 9).

Above 90 m from sample E479, Sample E477 occurs *Miogypsina borneensis* Tan Sin Hok, carrying the character (X = 6 to 8), and *Miogypsinoides bantamensis* (Tan Sin Hok), carrying the character (X = 14), and *Elphidium* spp. This horizon is correlated with the Karabayir Formation due to occurrence of *Miogypsinoides bantamensis* and *Miogypsina borneensis,* and then the age of the horizon is assigned to the Early Miocene (Aquitanian) (Figure 9).

Sample E475, at about 50 m above from sample E477, yields *Miogypsina globulina* and *Operculina complanata* (Defrance). *Miogypsina globulina* with 11 specimens has been measured, and they are the character of the followings: DI = 108 x 108 micron, DII = 150 x 125 micron, DII/DI = 1.39, V = 40.7, $\gamma = 40^o$; DI = 200 x 163 micron, DII = 238 x 175 micron, DII/DI = 1.29, V = 37.0, $\gamma = 10^o$; DI = 165 x 140 micron, DII = 173 x 103 micron, DII/DI = 1.05, V = 43.5, $\gamma = 15^o$; DI = 148 x 105 micron, DII = 198 x 118 micron, DII/DI = 1.34, V = 29.6, $\gamma = 5^o$; DI = 165 x 135 micron, DII = 207 x 116 micron, DII/DI = 1.25, V = 38.5, $\gamma = 30^o$; DI = 140 x 130 micron, DII = 210 x 125 micron, DII/DI = 1.50, V = 44.4, $\gamma = 15^o$; DI = 125 x 123 micron, DII = 163 x 125 micron, DII/DI = 1.30, V = 40.0, $\gamma = 25^o$; DI = 168 x 166 micron, DII = 235 x

123 micron, DII/DI = 1.39, V = 37.0, γ = 20^o; DI = 175 x 140 micron, DII = 240 x 150 micron, DII/DI = 1.37, V = 34.8, γ = 20^o; DI = 118 x 108 micron, DII = 125 x 116 micron, DII/DI = 1.06, V = 33.3, γ = 15^o, and DI = 145 x 165 micron, DII = 213 x 116 micron, DII/DI = 1.47, V = 30.4, γ = 25^o. *Miogypsina globulina* is generally characterized by the data of mean V of 37.2 and mean γ of 20^o (n = 11), and is regarded as the form of the stratigraphic position between *M. globulina* of Tungliang Well TL1, Taiwan (mean V = 23.58, mean γ = 15^o, n = 4) and *M. globulina* of Nogami Area, Obata Formation, Tomioka Group, Japan (mean V = 43.93, mean γ = 40^o, n = 20)(Figures 6-7). Therefore the age of *Miogypsina globulina* from sample E475 is probably situated in Early Miocene (Burdigalian) (Figure 9).

Sample E471, about 20 m above from sample E475, yields *Miogypsina intermedia* Drooger, which has the character such as DI = 173 x 148, DII = 175 x 75 micron, DII/DI = 1.01, V = 49, and γ = 30^o. As such *Miogypsina intermedia* from sample E475 is correlated with *M. intermedia,* associated with *M. globulina* from the Obata and Idozawa Formations, Tomioka Group, and other Japanese Miocene sedimentary rocks, i.e. Yabuzuka Formation in Ota City (Matsumaru and Takahashi, 2000) (Figures 6-7). The age of *M. intermedia* bearing sample E471 horizon is assigned to the Middle Miocene (Langhian) (Figure 9).

2. Saribuğday Köyü Section, Palu Area

Sample M230 in Saribuğday Köyü Section, Palu Area (Uysal et al., 1985) yields *Pararotalia mecatepecensis* (Nuttall), *Paleomiogypsina boninensis* Matsumaru, *Nummulites fichteli* Michelotti, *Lepidocyclina isolepidinoides* van der Vlerk, *Eulepidina dilatata* (Michelotti), *Borelis pygmaeus* (Hanzawa), and *Austrotrillina* spp. As such this fauna is correlated with the fauna of samples 77/59 to 77/57 in Ahirdaği Section, Maraş Area, as stated above, due to occurrence of *Paleomiogypsina boninensis* (Figure 9). As the author has described the evolution from *Pararotalia mecatepecensis* (Nuttall) to *Paleomiogypsina boninensis* Matsumaru, both species could be found in sample M230 (Matsumaru, 1996, p. 56, fig. 24) (Figure 4). The basal Sample M224, about 740 m below from Sample M230, yields *Lepidocyclina isolepidinoides* van der Vlerk, carrying the character (DI = 163 x 110 micron, DII = 175 x 105 micron, and 6 nepionic spirals), *Eulepidina dilatata, Nummulites fichteli*, *N. vascus* Joly and Leymerie, and *Borelis pygmaeus* (Hanzawa), and is regarded as the basal Tertiary d of the Letter Stages, although there is no miogypsinid foraminifera. However it is worth to describe the basal Oligocene in this area.

Sample M232, about 40 m above from sample M230, yields *Miogypsinella boninensis* carrying the character (X = 23, DI = 110 x 90 micron, and DII = 90 x 60 micron), *Nummulites fichteli, Nephrolepidina marginata, Eulepidina dilatata, Borelis pygmaeus, Heterostegina* spp., *Halkyardia minima* (Liebus), and *Operculina* spp. Top sample M233, about 130 m above from sample M232, yields *Miogypsinella boninensis,* carrying the character (X = 26, DI = 110 x 95 micron, and DII = 85 x 40 micron), *Miogypsinella complanata* (Schlumberger), carrying the character (X = more than 18, DI = 110 x 103 micron, and DII = 88 x 30? micron), *Paleomiogypsina boninensis, Pararotalia mecatepecensis*, and rarely *Nummulites fichteli*. Therefore these fauna from three samples (M230, M232, and M233) are correlated with the Assemblage IV from the Minamizaki Limestone due to occurrence of *Paleomiogypsina boninensis, Miogypsinella boninensis, Eulepidina dilatata, Nephrolepidina marginata, Borelis pygmaeus,* and *Halkyardia minima* (Matsumaru, 1996). Then these fauna from Saribuğday Köyü is assigned to Tertiary d stage of the Letter Stages. *Nummulites fichteli* is known in the fauna from Saribuğday Köyü, but isn't known in the Assemblage IV from Ogasawara Islands. Also *Miogypsinella complanata* carrying the number of nepionic chambers (X = more than 18), is known to occur from the fauna of Saribuğday Köyü, but this species isn't known in association with *Nummulites fichteli* in the Tethys region as far as the author knows. Then *Nummulites fichteli* in sample M233 is considered to be reworked, and the fauna of sample M233 may be partly correlated with the Assemblage V from the uppermost Minamizaki Limestone, Ogasawara Islands, Japan (Matsumaru, 1996).

3. Okçülar Section, Palu Area

Sample 77/27B below the basalt layer in the Okçülar Section, Palu Area (Uysal et al., 1985) yield *Miogypsinoides formosensis* (Yabe and Hanzawa), carrying the character (X = 15, DI = 116 x 110 micron, DII = 95 x 63 micron, and AP = 210°), *Eulepidina dilatata, Nephrolepidina marginata* (Michelotti), *Cycloclypeus* spp. and *Operculina complanata* (Defrance). The fauna of sample 77/27B is correlated with the Assembalge 1 of the Küçükkoy Formation in the Korkuteri Area due to occurrence of *Miogypsinoides formosensis* (Matsumaru et al., 2010). In sample 77/27B, *Miogypsinella complanata*, carrying the character (X = more than 18, DI = 100 x 88 micron, and DII = 75 x 50 micron) is, however, found in association with *Miogypsinoides formosensis*, but *Miogypsinella complanata* is considered to be reworked.

Sample 77/26 above the same basalt layer yield *Miogypsinoides formosensis, Spiroclypeus* spp., *Heterostegina* spp., and *Operculina complanata,* in addition to *Nummulites vascus* Joly and Leymerie, which is characterized by having the character (DI = 100 x 98 to 263 x 193 micron, DII = 83 x 40 to 208 x 108 micron, distance and number of chambers in 1/2 whorl = 360 to 400 micron and 3, those in 1 whorl =825 to 875 micron and 8, those of 1 1/2 whorl = 1125 to 1200 and 13 to 17, and those in 2 whorl = 1405 to 1475 micron and 20 to 24), *Cycloclypeus koolhoveni* Tan Sin Hok, carrying the character (DI = 125 x 125 to 120 x 118 micron, DII = 168 x 73 to 175 x 58 micron, number of opeculine chamber = 3, and number of nepionic septa = more than 16), and *Miogypsinella complanata,* carrying the character (DI = 88 x 78 micron, DII = 72 x 38 micron, and X = 19), respectively. The latter three species of *Nummulites vascus, Cycloclypeus koolhoveni,* and *Miogypsinella complanata* are considered to be reworked due to non coexistence.

Sample 77/20, about 50m above from Sample 77/26, yield *Miogypsinoides dehaartii,* carrying the character (X = 6, DI = 145 micron, DII/DI = 1.14; X = 6, DI = 153 x 125 micron, DII = 150 x 123 micron, DII/DI = 0.98; and X = 7, DI = 175 micron, DII/DI = 0.74) in three specimens, *Miogypsina borneensis,* carrying the character (X = 6, DI = 145 x 125 micron, γ = 40°; and X = 7, DI = 175 x 175 micron, DII = 130 x 63 micron, γ = 40°) in two specimens, *Eulepidina dilatata, Nephrolepidina marginata,* and *Operculina complanata.* Sample 77/19, 20 m above from Sample 77/20 yields *Miogypsinoides dehaartii, Operculina complanata,* and *Cycloclypeus* spp., in addition to *Paleomiogypsina boninensis,* and *Miogypsinella ubaghsi* (Tan Sin Hok), carrying the character (X = 24, DI = 63 x 58 micron, DII = 50 x 43 micron, AP = 425°, and diameter of spiral chambers = 650 x 763 micron). The latter two species are considered to be reworked, but the discovery of *Miogypsinella ubaghsi* is important to consider the evolutional lineage from *Miogypsinella boninensis* to *Miogypsinella ubaghsi* based on Tan Sin Hok's nepionic acceleration (Figure 4). This lineage has been considered as the evolution from *Miogypsinella boninensis* in the Assemblage V of the Minamizaki Limestone, Ogasawara Islands to *Miogypsinella ubaghsi* in the dredge limestones of the Komahashi-Daini Seamount, Kyushu – Palau Ridge as stated before (Figure 6-7).

Sample 77/18, about 20 m above from Sample 77/19 yields *Miogypsinoides formosensis,* carrying the character (X = 16, DI = 65 x 45 micron, DII = 112 x 80 micron, and AP = 270°), *Miogypsinoides bantamensis* (Axial section), *Miogypsina primitiva,* carrying the character (X = 11, DI = 125 x 116 micron, DII = 138 x 78 micron, and AP = 160°), *Heterostegina* spp., carrying the character (DI = 230 x 200 micron, and number of operculine chambers =3), and *Planorbulinella larvata* (Parker and Jones). Moreover Sample 77/16, about 40 m above from Sample 77/18, yields probable *Miogypsinoides formosensis, Heterostegina* spp., *Cycloclypeus* spp, and *Operculina complanata,* and is overlain by the basalt. In this section, all samples treated in the study belong to upper Oligocene and can be correlated with the Küçükkoy Formation in Korkuteri Area (Figure 9).

4. Ebürbahar Dere Section, Muş Area

Sample M27 in the Ebürbahar Dere, Muş Area (Uysal et al., 1985) yields *Paleomiogypsina boninensis,* carrying the character (DI = 125 x 125 micron, DII = 130 x 83 micron, 17 to 20 spiral chambers in 2 whorls, and diameter of nepionic spirals = 900 to 1050 micron), *Nephrolepidina marginata* (Michelotti), *Borelis pygmaeus, Operculina* spp., and *Peneroplis* spp. This sample is a horizon about 800 m above from the boundary between the Eocene and Oligocene sedimentary rocks, and is correlated with Samples 77/59 to 77/ 57 in the Ahirdaği Section, Maraş Area, and Sample M230 in the Saribuğday Köyü Section, Palu Area, due to occurrence of *Paleomiogypsina boninensis* (Figure 9). Sample M5, about 722 m above from Sample M27 yields *Miogypsinella boninensis,* carrying the character (DI = 70 x 50 micron, and diameter of nepionic spirals =745 micron), *Eulepidina dilatata, Nephrolepidina* spp., and *Spiroclypeus* spp. This horizon is correlated with Samples M 232 and M233 in Saribuğday Köyü Section, Palu Area, due to occurrence of *Miogypsinella boninensis* (Figure 9). Moreover Sample M1, about 450 m above from Sample M5 yields *Miogypsinoides bantamensis,* carrying the character (dimension of protoconch (diam. x height.) of 223 x 208 micron, and dimension of deuteroconch (diam. x height.) of 175 x 118 micron in axial section, and form ratio of diameter/thickness (F. R. = 1.5 mm/ 0.58 mm = 2.61)), *Miogypsina primitiva*, carrying the character (X = more than 10, DI = 183 x 175 micron, and DII = 173 x 123 micron), *Eulepidina dilatata, Heterostegina* spp., carrying the character (DI = 318 x 283 micron, DII = 365 x 188 micron, and 7 nepionic chambers in 1 whorl), and *Spiroclypeus* spp. This fauna from Sample M1 is correlated with the fauna of Sample 77/18 in the Okçülar Section, Palu Area, due to occurrence of *Miogypsinoides bantamensis* and *Miogypsina primitiva* (Figure 9).

5. Keleres Dere Section, Muş Area

Sample O155 in the Keleres Dere Section, Mus Area (Uysal et al., 1985) yields *Paleomiogypsina boninensis,* carrying the character (X = more than 20, DI = 110 x 108 micron, and DII = 112 x 58 micron), *Heterostegina* spp., *Borelis pygmaeus, Peneroplis* spp. and *Austrotrillina* spp. This fauna is correlated with the fauna of Sample M27 in the Ebürbahar Dere Section, Muş Area; Sample M230 in the Saribuğday Köyü Section, Palu Area; and Samples 77/59 to 77/57 in the Ahirdaği Section in Maraş Area, due to occurrence of *Paleomiogypsina boninensis,* respectively. Sample O148, placed about 310 m thick above from Sample O155 yields *Miogypsinella boninensis, Heterostegina* spp. and *Planorbulinella larvata*. Sample 142, placed more than 1000m above from Sample O148, yields *Miogypsenella boninensis,* carrying the character (X = more than 23, DI = 110 x 105 micron, DII = 112 x 73 micron, and diameter of nepionic spirals = 865 micron), and *Operculina complanata,* carrying the character (DI = 250 x 208 micron, DII = 238 x 135 micron, and distance and number of chambers in 1/2 whorl = 700 micron and 3, those in 1 whorl = 1125 micron and 8, those in 1 1/2 whorl = 1400 micron and 18, and those in 2 whorl = 3700 micron and 28). The fauna from Samples O148 to M142 is correlated with the fauna of Samples M232 to M233 in the Saribuğday Köyü Section, Palu Area, due to occurrence of *Miogypsinella boninensis*, respectively.

Sample M139, placed about 650 m above from Sample M142, yields *Miogypsinoides bantamensis,* carrying the character (X = 12, DI = 118 x 120 micron, DII = 100 x 60 micron, and diameter of nepionic spirals = 600 micron), *Spiroclypeus* spp., *Eulepidina dilatata*, and *Lepidocyclina boetonensis* van der Vlerk. Sample M133, placed about 300 m above from Sample M139, yields *Miogypsina borneensis*, carrying the character (X = 7, DI = 171 x 170 micron, DII = 190 x 100 micron, $\gamma = 30^{o}$, and diameter of nepionic spirals = 625 micron), *Heterostegina* spp., and *Operculina complanata.* Sample M131, placed obscure rightly, but about 60 m thick above from Sample M133, yields *Miogypsinoides bantamensis*, carrying the character (X = 11, DI = 113 x 105 micron, DII = 113 x 75 micron, γ = 20º, and diameter of nepionic spirals = 525 micron, and AP = 170º), *Miogypsinoides dehaartii,* carrying the character (X = 6, DI = 158 x 113 micron, DII = 158 x 105 micron, and γ = 20º), and *Miogypsina borneensis,* carrying the character (X = 7, DI = 135 x 120 micron, DII = 150 x 85 micron, and γ = 20º). As such the fauna of Samples M139 to M131 is correlated with the fauna of Sample M1 in the Ebürbahar Dere Section, Muş Area; and Samples 77/20 to 77/18 in the Okçülar Section, Palu Area, due to occurrence of *Miogypsinoides bantamensis, Miogypsinoides dehaartii, Miogypsina primitiva,* and/or *Miogypsina borneensis,* respectively. Moreover these fauna are correlated with the fauna of the Assemblage 1 in the Küçükkoy Formation in Korkuteri Area (Figure 9).

5. Conclusion

The Miogypsinid foraminifera (Order Foraminiferida) in the Tethys Region are known to occur from the Early Oligocene (Rupelian) to Middle Miocene (Serravallian) age. Characteristic faunal assemblages from the Miogypsinid foraminiferal Biostratigraphy in Japan, Taiwan and Turkey have been known and correlated each other, respectively (Figures 6-7, 9). Judging from the correlation and analysis of faunal assemblages, the following evolution is established: *Paleomiogypsina boninensis* was proved to be a diagnostic species for the basal assemblage of the Early Oligocene (Rupelian), and *Paleomiogypsina boninensis* evolved from *Pararotalia mecatepecensis* due to having co-existence, and trochoid nepionic spirals in the Minamizaki Limestone, Ogasawara Islands, Japan (Matsumaru, 1996) (Figures 6-7). *Miogypsinella boninensis* evolved from *Paleomiogypsina boninensis,* and evolved into *Miogypsinella ubaghsi* during Late Oligocene (Chattian), based on the biostratigraphic relationship between the Minamizaki Limestone and limestones of Komahashi-Daini Seamount, Kyushu – Palau Ridge, Japan (Figures 6-7). *Miogypsinella ubaghsi* may evolve into *Miogypsinella complanata* due to nepionic acceleration, but there is no discovery on direct evidences in the field. However there is evidence of the evolution from *Miogypsinella ubaghsi* to *Miogypsinella borodinensis* (= *Miogypsinoides formosensis*) during the Late Oligocene (Chattian), based on the biostratigraphic relationship between limestones of Komahashi-Daini Seamount and basal Zone 5 drill cores of the Kita-Daitojima Limestone, Kita-Daito-Jima, Okinawa Prefecture, Japan (Figures 6-7). However *Miogypsinella complanata* is missing in both limestones as stated above, but probably has been existed as co-existence. *Miogypsinella complanata* and *Miogypsinoides formosensis* are found together, but both species are associated with *Paleomiogypsina boninensis* and *Miogypsinoides bantamensis* in Sample 97-486 in Section 4 and Sample 97-502 in Section 6 in the Küçükkoy Formation, Bey Dağlari Autochton, Menderes–Taurus Platform, Turkey (Matsumaru et al., 2010). Then *Paleomiogypsina boninensis* and *Miogypsinella complanata* are regarded as the reworking. During Late Oligocene (Chattian), *Miogypsinoides formosensis* evolved into *Miogypsinoides dehaartii* through *Miogypsinoides bantamensis* due to the nepionic acceleration, and *Miogypsinoides dehaartii* evolved into *Miogypsina primitiva* due to having the lateral chambers during the depositional age of the Küçükkoy Formation (Figures 6-7, 9). Moreover, *Miogypsina primitiva* evolved into *Miogypsina borneensis* due to the nepionic acceleration in the Küçükkoy Formation during Late Oligocene (Chattian) (Figures 6-7, 9). In the Early Miocene (Aquitanian), *Miogypsina borneensis* from the Küçükkyoy Formation evolved into *Miogypsina globulina* from the Karabayir Formation, Bey Dağlari Autochton (Figures 6-7, 9). Further *Miogypsina globulina* evolved into *Miogypsina intermedia* due to occurrence and nepionic acceleration (Drooger, 1952, 1963). *Miogypsina intermedia* evolved into *Miogypsina cushmani* due to the nepionic acceleration during Early Miocene (Burdigalian)/ Middle Miocene (Langhian) age, and these are shown in Indian and Japanese *Miogypsina* (Raju, 1974; Matsumaru, 1967, 1977; Matsumaru and Takahashi, 2004). Also their evolution is shown in the biostratigraphical correlation between the Karakuştepe Formation carrying *Miogypsina globulina* in Korkuteri Area, Bey Dağlari Autochton, Menders - Taurus Platform, and Sample E471 beds carrying *Miogypsina intermedia* in Ahirdaği Section in Maraş Area, Menderes - Taurus Platform, Turkey (Figure 9). *Miogypsina nipponica* (= *M. antillea* and *M. cushmani* steps of nepionic acceleration) was found from the Kamiyokoze Formation of the Middle Miocene (Serravallian) age, and this species evolved from *Miogypsinid cushmani* of nepionic acceleration by Indian and Japanese Miogupsinid researches (Raju, 1974; Matsumaru, 1980; Matsumaru and Takahashi, 2004). The ancestor of *Miolepidocyclina burdigalensis* (Gümbel), *Lepidosemicyclina thecidaeformis* (Rutten), *Tania inokoshiensis* Matsumaru, *Boninella boninensis* Matsumaru and *Spinosemiogypsina antalyaensis* Matsumaru, Özer and Sari isn't known, although some are considered, and it will be solved from further Miogypsinid foraminiferal Biostratigraphy. Some new genera by the author's research have been known from Miogypsinid foraminifera from the Philippines Archipelago, eastern Tethys region, and they will contact the unknown lineage soon.

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