SOME MIOCENE *Nephrolepidina* (FAMILY LEPIDOCYCLINIDAE) FROM THE SHIMOSHIROIWA FORMATION, IZU PENINSULA, JAPAN

KUNITERU MATSUMARU

Department of Geology, Faculty of Education, Saitama University, Urawa, 338 Japan

**ABSTRACT**—Seven taxa of the genus *Nephrolepidina* (Family Lepidocyclinidae) are described and illustrated from the Upper Miocene Shimoshiroiwa Formation which crops out in the Izu Peninsula, Shizuoka Prefecture, Japan. They are reviewed in this paper in careful comparison with the taxa formerly described by many authors. One of which is described in this paper as a new subspecies, which is distinguished from *Nephrolepidina sumatrensis* (Brady) by its prevalent development of spatulate or hexagonal equatorial chambers.

Key words: *Nephrolepidina*, Shimoshiroiwa Formation, Izu Peninsula

**INTRODUCTION**

Shimoshiroiwa (or Shimoshiraiwa) is famous as one of the classical localities of *Nephrolepidina* in Japan, and is located about 5 km east of Shuzenji Spa, Takata-gun (Izu Peninsula), Shizuoka Prefecture (34°58'N, 138°59'E). Hanawa (1931b) described the *Nephrolepidina* species from calcareous sandstone and limestone lens within a thick dacitic tuff of the Shimoshiroiwa Formation and suggested that they indicate a correlation with the Buriogal Stage of the European standard. Saito (1963) described a planktonic foraminiferal assemblage from a calcareous sandstone containing *Nephrolepidina* and stated that the planktonic foraminifers represent the *Globorotalia mayeri* / *Globigerina nepenthes* Subzone of Blow's (1959) zonation. Recently, the present author (1981) and his collaborators (1981) tentatively concluded that the horizons of *Lepidocyclina rutteni* in the Shimoshiroiwa Formation and its equivalent formation in the Izu Peninsula should be assigned to Blow's N.17 zone of Late Miocene age because of the occurrences of *Lepidocyclina rutteni* van der Vlerk, *Globorotalia tumida plesirotumida* Blow and Banner, *Globocaudina dehiscens dehiscent* (Chapman, Parr and Collins) and *Sphaeroidina lobellii* subdehiscent cyanocephala Blow.

The purpose of the present paper is to give systematic descriptions of *Nephrolepidina* from the Shimoshiroiwa Formation based on morphological characters. The type specimens and slides described herein are in the collections of the Department of Geology, Faculty of Education, Saitama University.

**SYSTEMATIC DESCRIPTIONS**

Family Lepidocyclinidae Schepan, 1932

Genus *Nephrolepidina* H. Douvillé, 1911

*Nephrolepidina martini* (Schlumberger, 1900)

Figs. 1–5

*Lepidocyclina martini* Schlumberger, 1900, p. 131–133, pl. 6; Caudri, 1939, p. 212–218, pl. 8, figs. 57–60; Coleman, 1963, p. 14–15, pl. 3, figs. 7–14.

*Lepidocyclina* (Nephrolepidina) *martini* Schlumberger. van der Vlerk, 1928, p. 187, pl. 12, figs. 23a–c; Cole, 1945, p. 288–289, pl. 25, figs. 1–4; Eames et al., 1962, p. 303, 316, pl. 6, figs. 2–4, pl. 8, fig. 1;Cole, 1963, p. E22–23, pl. 10, figs. 10, 12, 15–17, pl. 11, figs. 9–17.

*Lepidocyclina rutteni* forma *globosa* Scheffen, 1932, p. 40–41, pl. 10, figs. 1–3.

*Lepidocyclina* (Eudelepidina) *martini* Schlumberger. Cole, 1960, p. 102, pl. 12, figs. 1–3.


**Description.**—Test small, lenticular, and rayed, with six to eight rays. Diameter 2.8 to 4.4 mm., including rays, and thickness 1.0 to 1.4 mm. Surface of test covered with papillae, which are small, being less than 98 μm in diameter. Embryonic apparatus varies from nephrolepidine to trybiloidepine types in terms of megaglobo- spheric nucleoconch. Diameter of whole embryonic apparatus 305 to 330 μm across both protoconch and deuteroconch chambers, and 308 to 490 μm at right angles to preceding. Protoconch spherical, internal diameter 158 to 195 μm, and deuteroconch reniform, largest inner diameter 224 to 308 μm. Wall of embryonic apparatus 29 to 40 μm thick. Embryonic apparatus 180 to 185 μm high in vertical section. There are 4 to 8 small adaxial chambers, resting on outerwall of deutero- conch. Equatorial chambers arcuate at center, but spatulate or hexagonal near adult stage in equatorial section, gradually increasing height of equatorial chambers from central part to periphery in vertical section. Along one ray, near periphery, chamber measuring 70 to 80 μm in radial diameter, and 50 to 63 μm in tangential diameter. Between rays chambers measuring 58 to 65 μm radially, and 63 to 70 μm tangentially. Chamber wall 11 to 14 μm thick. Lateral chambers arranged in regular tiers, and there are seven to eight layers of lateral chambers over central portion of test. Typical chambers at periphery and over central portion 150 to 200 μm long, and 34 to 36 μm high, with floors and roofs 15 to 20 μm thick.

**Remarks.**—Fifteen Shimoshiroiwa specimens selected at random are sectioned. All of them represent only the megaglobose form. They agree in all the features with *Lepidocyclina martini* as mentioned above. There are,
Fig. 1. Miocene *Nephrolepidina* from the Shimoshiroiwa Formation, Izu Peninsula, Japan (1). All from sample SH 3 of Matsumaru *et al.* (1981). Scale bars, A–C=1 mm; A for 1, 6, 8–9, 11, B for 10, and C for 2–5, 7, 1, 6a, 8 and 9, lateral views; 6b and 11, oblique views; 2, 4–5, 7 and 10, equatorial sections; 3, vertical section. 1–5. *Nephrolepidina martini* (Schlumberger). 6–7. *Nephrolepidina angulosa* (Provale). 8–11. *Nephrolepidina ruinosa* (van der Vliek).
however, problems with their generic classification. Recently, Loeblich and Tappan (1988) established *Asterolepida*ina so as to include stellate or radial forms of *Lepidocyclina*, with *Lepidocyclina asterodisca* Nuttall, 1932 being designated as the type species. Then the form from the Shimoshiroiwa may be assigned to this genus. Cole (1958) has noted, however, in regard to *Lepidocyclina asterodisca* from the Cuban Oligocene that specimens with rays are megalospheric forms and represent the asexual generation, whereas those large, circular, compressed lenticular specimens without traces of ray are microspheric specimens and represent the sexual generation. He observed that embryonic chambers of this species are composed of two subequal chambers, and assigned *Lepidocyclina asterodisca* to the subgenus *Lepidocyclina*. Generally, the generic distinction of the Family Lepidocyclinidae is based mainly on characters of megalospheric apparatus, hence the author regards *Asterolepida*ina as an invalid taxon.

In 1928, van der Vlerk proposed the subgenus *Trybliopleidina* for *Lepidocyclina orientalis* van der Vlerk, *L. talahabensis* van der Vlerk, *L. ephippioides* Jones and Chapman, and *L. rutteri* van der Vlerk, all of which possess a nucloconch in the shape of a cupule. He considered the *Trybliopleidina* to be of great importance as an index group of the uppermost part of the Tertiary stage which in reality means the Upper Miocene. But he did not indicate the type species. Afterwards, Berry (1929) designated *Orbiculoidea* (Lepidocyclina) ephippioideos Jones and Chapman, 1900 to be the type species of *Trybliopleidina*. As most specimens of *Lepidocyclina ephippioideos* have a large test and eulideine-type embryonic chambers, *Trybliopleidina* can be recognized as a subjective synonym of *Eulepidina*. As the other three species have nephrolepidine to trybliopleidine embryonic chambers, they do not belong to *Eulepidina*. There has been such a confusion with the usage of the types of embryonic apparatus, but all the smaller *Lepidocyclina* with nephrolepidine to trybliopleidine-type nucleoconch can be recognized to belong to the genus *Nephrolepidina* (Caudri, 1934, p. 119; Cole, 1945, p. 286; Eames et al., 1962, p. 292; Matsumaru, 1971, p. 168–170). Therefore, *Lepidocyclina martini* from the Shimoshiroiwa is placed in this paper under the genus *Nephrolepidina*.

Occurrence.—Lower part of the lower member of the Shimoshiroiwa Formation (SH 1 to SH 3 levels of Matsumaru et al., 1981).

Repository.—Saitama University Collection.

Nephrolepidina angulosa (Proval, 1909)

Figs. 1-6-7


*Lepidocyclina (Nephrolepidina) angulosa* Proval, Yabe and Hanzawa, 1924, p. 74–75, pl. 9, figs. 1–2, pl. 10, figs. 1–2, pl. 11, figs. 1–2, pl. 12, figs. 2–6; van der Vlerk, 1928, p. 187, 190, pl. 10, figs. 14c–e; van der Vlerk, 1929, p. 22, figs. 17, 46a–b; Yabe and Hanzawa, 1929, p. 170, pl. 20, figs. 3, 7, pl. 21, figs. 1–4, pl. 23, fig. 1, pl. 25, fig. 7, pl. 27, figs. 6–7; Cole, 1945, p. 287–289, pl. 24, figs. A–G; Hanzawa, 1957, p. 76–77, pl. 20, figs. 1–9, pl. 21, fig. 5, pl. 22, figs. 4, 14.

*Lepidocyclina (Amphilepidina) angulosa* Proval, Hanzawa, 1931b, p. 164, pl. 27, figs. 9–13.

*Lepidocyclina (Amphilepidina) polygonalis* Hanzawa, 1931b, p. 164–165, pl. 28, figs. 8–9.

*Lepidocyclina delitescens* Scheff., 1932, p. 23–24, pl. 2, figs. 1–2.


*Nephrolepidina angulosa* (Proval). Matsumaru, 1971, p. 168–169, pl. 12, figs. 1–10, pl. 13, figs. 1–11, pl. 14, figs. 7–15, 18–21 (non figs. 16–17), pl. 20, fig. 3, pl. 22, fig. 5, pl. 23, fig. 4.

*Non Lepidocyclina angulosa* Proval. H. Douville, 1912, p. 270, pl. 21, figs. 3–5; Ruten, 1914, p. 291–293, pl. 21, figs. 1–4; Vessem, 1978, p. 127, pl. 10, fig. 9.

Description.—Test small, thickly lenticular with flat-topped central boss and narrow peripheral flange. Diameter 2.1 to 4.6 mm, thickness 1.0 to 2.3 mm. More than five papillae, distributed circularly on flat top of central boss, 0.3 to 0.8 mm in diameter. Embryonic apparatus of nephrolepidine to trybliopleidine form of bilocular embryonic chambers, and diameter of whole embryonic chambers measuring 350 to 510 µm across both protoconch and deuteroconch, and 470 to 550 µm at right angles to preceding. Protoconch small, 220 to 280 µm in diameter, spheroidal in equatorial and vertical sections; deuteroconch large, 370 to 500 µm in diameter, kidney shaped in equatorial section, embracing protoconch along its circumference in equatorial section. Wall of embryonic chambers 30 to 48 µm thick. Embryonic chambers 155 to 195 µm high in vertical section, and there are 4 to 8 small adaxial chambers. Equatorial chambers of a single layer, of arcuate form in nepionic stage changing from ogival to hexagonal form in neanic stage through ontogeny, polygonal or stellate arrangement in equatorial section; generally 70 to 80 µm in radial diameter and 50 to 70 µm in tangential diameter near periphery; gradually increasing in thickness of floors and roofs of equatorial chambers from center to periphery. Lateral chambers large, subcircular to subreniform in shape in vertical section, 100 to 320 µm long, 30 to 45 µm high, with floors and roofs 15 to 20 µm thick over central portion of test. Number of lateral chambers per tier over embryonic chambers 12 to 14 layers in adult.

Remarks.—The test of the Shimoshiroiwa megalospheric specimen is characterized by a flat-topped central boss with more than five conical pillars formed with at least one concentric ring on the flat top of the central boss, and is essentially similar to the test characters of the original description given by Proval (1909) for *Lepidocyclina angulosa* from Borneo. Afterwards, both megalospheric and microspheric forms of *Lepidocyclina (Nephrolepidina) angulosa* Proval were reported by van der Vlerk (1928, 1929) from Borneo, but he did not give test characters of the microspheric form. Hanzawa (1931b) found microspheric specimens of *Lepidocyclina* from Shimoshiroiwa, which possess a central boss with large pustules, six or more in its center, and gave them a new specific name, *Lepidocyclina (Amphilepidina) polygonalis*. He did not compare this new species with the microspheric form of *Lepidocyclina angulosa*. It is impossible to discriminate *Lepidocyclina polygonalis* from the microspheric form of *L. angulosa* by their morphological characters alone. From the characters of megalospheric apparatus, *Lepidocyclina angulosa* is
placed in this paper under the genus Nephrolepidina.

Yabe and Hanzawa (1922, p. 49) described Lepidocyclina (Nephrolepidina) cfr. douvillei from the Abuta Limestone, Japan. According to Hanzawa (1957, p. 76), a much smaller size of lateral chambers of the Abuta specimens made it necessary for Yabe and Hanzawa (op. cit.) to group them under a new name of L. cfr. douvillei together with those specimens described earlier as Nephrolepidina angulosa from Nias (Douville, 1912, p. 270) and Borneo (Rutten, 1914, p. 291–293). These specimens are, however, better to be distinguished specifically from Nephrolepidina angulosa (Provalve, 1909).

Hanzawa (1947, p. 564; 1957, p. 77) believed that Lepidocyclina (Nephrolepidina) cfr. douvillei is the microspheric form of L. (N.) japonica (Yabe). Cole (1960, p. 102) and Chaproniere (1984, p. 61–62) considered that Nephrolepidina angulosa (Provalve) is a synonym of Nephrolepidina japonica. Coleman (1963, p. 18, pl. 6, fig. 4) could discriminate a typical specimen of L. (N.) angulosa from specimens of L. (N.) japonica from Guadalcanal Island, but he included L. (N.) angulosa in L. (N.) japonica. However, the present author indicated that Nephrolepidina angulosa, which possesses a flattened central boss and a series of strong papillae forming an apical crown of test, cannot be assigned to Nephrolepidina japonica (Matsumaru, 1971).

Occurrence.—Lower member and the lower part of upper member of the Shimoshiroawa Formation (SH 1 to SH 6 levels of Matsumaru et al., 1981).

Repository.—Saitama University Collection.

Nephrolepidina rutteni (van der Vlerk, 1924)

Figs. 1–8–11

Lepidocyclina rutteni van der Vlerk, 1924, p. 17–21, pl. 3, figs. 1–4; Caudri, 1939, p. 218–221, pl. 8, figs. 61–62, 64–65 (non fig. 63); Vessem, 1978, p. 129, pl. 9, figs. 2–3; pl. 10, fig. 13.

Lepidocyclina leytensis Yabe and Hanzawa, 1925, p. 107, 109, pl. 25, figs. 8–9, pl. 26, figs. 11–12, pl. 27, figs. 12–13, 15 (non fig. 14).

Lepidocyclina (Trybiolopida) rutteni van der Vlerk, 1928, p. 186, 202, pl. 10, figs. 12a–c; Matsumaru, 1981, p. 116–118, figs. 10–18.

Lepidocyclina (Amphilepidina) nipponica Hanzawa, 1931a, p. 151–152, pl. 24, figs. 4, 6–7, 11 (non figs. 1–3, 5), pl. 25, figs. 1–5; 1931b, p. 162–163, pl. 27, figs. 1–4.

Lepidocyclina (Nephrolepidina) rutteni van der Vlerk. Cole, 1945, p. 289–290, pl. 27, figs. A–G.

Lepidocyclina (Nephrolepidina) makiyamai Morishima, 1949, p. 212–
213, pl. 44, figs. 1–2, 4 (non fig. 3), pl. 45, fig. 2 (non figs. 1, 3–4).

Nephrolepidina japonica (Yabe). Matsumaru, 1971, p. 166, 168, pl. 23, fig. 6, pl. 24, figs. 3–6.

Description.—Test moderate in size, with or without a thin periphery, giving a polygonal outline of test, 4.0 to 6.9 mm in diameter, 1.0 to 1.8 mm thick. Surface ornamentation reticulate. Papillae small, weak, and better developed in center than at periphery, 90 to 100 μm in diameter. Embryonic apparatus varies from the advanced nephrolepidine to trybiolopideine form, 500 to 680 μm in diameter across both protoconch and deuteroconch chambers, and 650 to 680 μm at right angles to preceding. Protoconch 140 to 300 μm in diameter, and a major part of it embraced by deuteroconch having a 235 to 580 μm diameter. Embryonic apparatus 153 to 228 μm high in vertical section. Wall of embryonic apparatus 40 to 50 μm thick. Adaxial chambers numbering from 6 to 9, well developed on the outer wall of deuteroconch. Equatorial chambers of single layer in vertical section, are arcuate in nepionic stage, ogival to hexagonal or spatulate in neanic stage in equatorial section, polygonal or often subcircular arrangement in equatorial section. Chambers near periphery 90 to 119 μm in radial diameter, 60 to 70 μm in transverse diameter. Equatorial layer increases slowly and regularly in height from center to periphery of test, about 50 μm height at center, nearly 185 μm at periphery, both excluding floors and roofs. Floors and roofs of equatorial chambers about 8 μm thick at center, about 20 μm thick at periphery. Lateral chambers are large, subcircular to subreniform in shape in vertical section, and arranged in regular tiers in most specimens. At periphery lateral chambers 350 to 750 μm long, 80 to 95 μm high. There are 10 to 15 lateral chambers to a tier over embryonic apparatus. Thin pillars traversing layers of lateral chambers of 100 to 200 μm in peripheral diameter and tapering toward center of test.

Remarks.—The Shimoshiroawa specimens were compared with specimens in the collection of the Geological Museum of Bandung obtained from the type locality of Tijianang, west Preanger, and those in the author’s collection whose provenance being Pereng, about 10 km west of Yogyakarta, both in Java. Also, the author compared the measurement values of the Shimoshiroawa specimens with those of Lepidocyclina (Trybiolopida) rutteni van der Vlerk (1928, Table A), and found these two data being identical for the most part. Although the Shimoshiroawa specimens have a slightly larger test and rather spacious lateral chambers, there are no significant deviations from a gradational one. Accordingly, the Shimoshiroawa specimens are assigned to Nephrolepidina rutteni van der Vlerk, judging from the characters of megalospheric apparatus.

Occurrence.—Lower and upper members of the Shimoshiroawa Formation (SH 1 to 18 levels of Matsumaru et al., 1981).

Repository.—Saitama University Collection.

Nephrolepidina marginata (Michelotti, 1841)

Figs. 2–1–4

Nummulites marginata Micheloti, 1841, p. 297, pl. 3, figs. 4a–b.

Lepidocyclina marginata (Michelotti). Lemoine and R. Douville, 1904, p. 16–17, pl. 1, fig. 7, pl. 2, figs. 7, 9, 11, 20, pl. 3, figs. 3, 8–9, 13; Geyn and van der Vlerk, 1935, p. 253, figs. 25–27.

Lepidocyclina morgani Lemoine and R. Douville, 1904, p. 17, pl. 12, 15, pl. 17, figs. 4, 12, pl. 3, fig. 2.

Nephrolepidina marginata (Michelotti). H. Douville, 1925, p. 76–77, figs. 58–59, pl. 2, figs. 5–6; Gomez Llovec, 1929, p. 348–350, pl. 32, figs. 11–21; pl. 33, figs. 28.

Lepidocyclina (Amphilepidina) nipponica Hanzawa, 1931a, p. 151–152, pl. 25, fig. 2 (non figs. 1, 3–5), pl. 24, figs. 1–7, 11.

Lepidocyclina (Amphilepidina) scabra Hanzawa, 1931b, p. 165–166, pl. 27, figs. 14–15, pl. 28, figs. 2–4.

Lepidocyclina (Nephrolepidina) marginata (Michelotti). Brönnimann, 1940, p. 54–55, pl. 4, figs. 5, 7–8, pl. 5, fig. 13, 19–20.

Lepidocyclina (Nephrolepidina) morgani Lemoine and R. Douville.

Hanzawa, 1957, p. 79, pl. 19, figs. 2a–d, pl. 22, figs. 9–10.

Nephrolepidina marginata (Lemoine and R. Douville). Lange, 1968, p. 63–65, 67–68, pl. 1, fig. 2; Matsumaru, 1971, p. 172, figs. 1–4, 6–11 (non fig. 5), pl. 19, figs. 1–4, 7, 11–13 (non figs. 5–6, 8–10, 14–15).

Nephrolepidina japonica (Yabe). Matsumaru, 1971, p. 166, 168, pl. 14, figs. 3–6 (non figs. 1–2), pl. 17, figs. 12–18 (non figs. 7–11, 19).

Description.—Megalospheric test, small to moderate in size, with or without a thin periphery, 3.6 to 5.1 mm in diameter, 1.5 to 2.2 mm thick. Test obese, biconvex with flat-topped central boss, outline polygonal to rounded, with large conical pustules (i.e. 175 to 400 μm in diameter) distributed at least in one concentric ring around central boss of test surface. Some pustules are distributed spirally in central boss. Bilocular embryonic chambers nepholipedinid type, and whole embryonic chambers measuring 420 to 453 μm in diameter across both protoconch and deuteroconch, and 465 to 475 μm at right angles to preceding. Protoconch spherical, 200 to 225 μm in internal diameter, and deuteroconch reniform, 380 to 385 μm in inner diameter. Embryonic chambers 150 to 230 μm high in vertical section. Wall of embryonic chambers numbering from 4 to 7. Equatorial chambers arcuate through ogival to hexagonal or spmatulate through ontogeny in equatorial section, polygonal to subcircular arrangement in equatorial section. Those near periphery being 90 to 98 μm in radial diameter, 60 to 70 μm in transverse diameter. Equatorial layer 48 to 65 μm high near center, and 130 to 150 μm near periphery, excluding floors and roofs which are about 25 μm thick. Lateral chambers rectangular, open and arranged in regular tiers. There are 10 to 15 chambers to a tier on each side of equatorial layer. Chambers over center and at periphery 110 to 200 μm long, 48 to 50 μm high, and floors and roofs 9 to 32 μm thick.

Microspheric test, rather large with an inflated central area, surrounded by a relatively wide flat rim. Test 11 to 14 mm in diameter; inflated portion 7.8 to 8.4 mm in diameter; test 4.0 to 4.4 mm thick, ornamented by numerous pustules which are evenly and regularly distributed all over the surface, and between pustules there is a faint polygonal mesh representing outline of lateral chambers. Initial chamber, proloculus, spherical, 17 to 18 μm in diameter, and its wall about 3 μm thick. There are 2 operculine chambers with proximal stolons only after second chamber, deuteroconch, and chambers beyond these are followed by chambers with proximal stolons and retroverted stolons. Each chamber giving rise to two nepionic spirals. Equatorial chambers arcuate through ogival to hexagonal or spmatulate through ontogeny in equatorial section, polygonal to subcircular arrangement. Lateral chambers have distinct, open, rectangular cavities, and gradually and regularly decrease in size toward equatorial layer. There are 22 to 24 lateral chambers to a tier on each side of equatorial layer. Strong pillars distributed in vertical section, their surface diameter being 200 to 400 μm; larger ones occurring in central area.

Remarks.—Hanzawa (1931b) described both microspheric and megalospheric specimens, which are in the same form group as the two types of specimens described in this study under the name Lepidocyclina (Amphilepidina) scabra sp. nov. He considered that the microspheric form of L. (Amphilepidina) scabra resembled L. (Nephrolepidina) praemarginata R. Douvillé, 1908, in a general configuration of the test surface, but distinguished it from the latter by being larger in size and having a larger number of pillars and spmatulate equatorial chambers. Unfortunately, he did not compare the present form with Nephrolepidina marginata (Michelotti). The microspheric specimens from Shimoshirioiwa examined in this study have the same external and internal characters as those described and illustrated for Nephrolepidina marginata (Michelotti), 1841.

Hanzawa (op. cit.) considered the megalospheric specimens of Lepidocyclina (Amphilepidina) scabra to resemble L. (Nephrolepidina) morgani Lemoine and R. Douvillé, 1904, in external character, but he distinguished the former from the latter by having more numerous pustules.

The present author regards that Lepidocyclina (A.) scabra is a synonym of Nephrolepidina morgani. Douvillé (1925, p. 58–59) found Nephrolepidina marginata in association with N. tournoeuri in Camp du Rarlé, Morocco. He (Ibid., p. 62) also recognized that the microspheric specimens of Lepidocyclina morgani were associated with the megalospheric specimens of both Nephrolepidina tournoeuri and N. morgani in Andalusia, Spain. So, there occurs a problem whether the megalospheric specimens of Nephrolepidina marginata are to be referred either to Nephrolepidina tournoeuri or N. morgani. In relation to these species, Douvillé (Ibid., p. 75) summarized the characters of such different species as partita n. sp., praemarginata, marginata, simplex n. sp., and tournoeuri and morgani.

According to him, the megalospheric form in this report should be placed under Nephrolepidina morgani Lemoine and R. Douvillé, 1904. Thus, at Shimoshirioiwa, Nephrolepidina morgani occurs together with Nephrolepidina marginata. The present author realizes a possibility that Nephrolepidina morgani and N. marginata will be grouped together as a dimorphic form of the same species. Then, both megalospheric and microspheric generations from Shimoshirioiwa are assigned to Nephrolepidina marginata (Michelotti).

Occurrence.—Lower and upper members of the Shimoshirioiwa Formation (SH 1 to SH 6 levels of Matsumaru et al., 1981).

Repository.—Saitama University Collection.

Nephrolepidina japonica (Yabe, 1906)

Figs. 2.5–8

Orbitoides (Lepidocyclina) japonicus Yabe, 1906, p. 317–320, figs. 1–2.

Lepidocyclina (Nephrolepidina) japonica Yabe. Yabe and Hanzawa, 1922, p. 47–49, pl. 6, figs. 3–4, pl. 7, figs. 2–5; van der Vlerk, 1928, p. 186, 199, figs. 22a–c; Koike, 1951, p. 87–92, pl. 2, figs. 1–11; Coleman, 1963, p. 17–18, pl. 6, figs. 1–2, 5 (non figs. 3, 4, 6); Chaproniere, 1984, p. 61–62, pl. 20, fig. 13.

Lepidocyclina (Amphilepidina) nipponica Hanzawa, 1931a, p. 151–152, pl. 24, figs. 1–3, 5 (non figs. 4, 6, 7, 11), pl. 25, figs. 3–4 (non figs. 1–2, 5), pl. 26, figs. 1–3, 5; 1931b, p. 162–163, pl. 28, figs. 107 (non fig. 111).

Lepidocyclina (Amphilepidina) japonica Yabe. Hanzawa, 1931b, p. 163–164, pl. 28, figs. 5, 7.

Lepidocyclina (Nephrolepidina) nipponica (Hanzawa). Hanzawa, 1943, p. 128, pl. 7, figs. 1–7, pl. 8, figs. 1–5; 1957, p. 80, pl. 19, figs. 1a–d, 4a–e.

Lepidocyclina (Nephrolepidina) makkusai Morishima, 1949, p. 212–213, pl. 44, fig. 3 (non figs. 1–2, 4), pl. 45, figs. 1, 3–4 (non fig. 2).

Nephrolepidina japonica (Yabe). Matsumaru, 1967, p. 134–141, figs. 6–31, pl. 7, figs. 1–4, 6, 8–9 (non figs. 5, 71, pl. 8, figs. 1–8); 1971, p.
Description.—Test small, lenticular with an inflated central part bounded by a narrow flat rim, 3.3 to 4.5 mm in diameter, and 1.3 to 1.8 mm in thickness. There is an apical group of 8 to 13 small pastules, 100 to 200 μm in diameter. Embryonic chambers nerepholidine type, and whole embryonic chambers attaining a 358 to 400 μm diameter across both protoconch and deuteroconch, and 378 to 425 μm at right angles to preceding. Protoconch spherical, 200 to 220 μm in internal diameter, and deuteroconch reniform, 294 to 330 μm in inner diameter. Embryonic chambers ellipsoidal in general, extending towards periphery, about 330 μm long, 220 μm high in vertical section. Wall of embryonic chambers 25 to 40 μm thick. Adaxiliary chambers numbering from 4 to 6. Equatorial chambers arcuate form in n epionic stage, changing from ogival to hexagonal or spatulate form in neanic stage through ontogeny, polygonal arrangement in equatorial section. Chambers near periphery being 85 to 90 μm in radial diameter, 48 to 50 μm in transverse diameter. Equatorial layer 50 to 60 μm high near center, 128 to 145 μm near periphery. Thickness of floors and roofs 8 to 10 μm near center, 12 to 20 μm at periphery. Lateral chambers subcircular in vertical section, more or less spacious, especially wide in tiers near surface of central but, narrow in tiers just above embryonic chambers. Those at periphery being 100 to 110 μm long, 35 to 38 μm high, and floors and roofs 8 to 25 μm thick. Number of chambers in a tier over embryonic chambers forming 8 to 12 layers. Pillars especially thick at end part of central boss of test, thin near skirts of central boss to peripheral part, thickness ranging from 20 to 210 μm.

Remarks.—Specimens from Shimoshiroiwa have the essential features of Nerepholidina japonica (Yabe) described by Yabe (1906), Yabe and Hanzawa (1922) and the author (1967) from the type locality of Abuta, Nakaosaka, Gunma Prefecture, Japan. This species is characterized by a small test and by a neuleoconch of nerepholidine type, more spacious lateral chambers, somewhat thicker pillars on the apical part of the test, and equatorial chambers arranged somewhat polygonally. Hanzawa (1947) has placed Lepidocyclina (Nerepholidina) nipponica (Hanzawa) in the synonymy of L. (N.) japonica (Yabe), and also the author (1971) regarded the former as a synonym of the latter. However, some specimens of Nerepholidina rutteni, N. marginata, N. japonica and N. sumatrensis from Shimoshiroiwa are separated from Nerepholidina nipponica, especially on the basis of description and illustration of the respective species by many authors (van der Vlerk, 1924, 1928; Michelotti, 1841; Lemoine and R. Douville, 1904; Yabe, 1906; Yabe and Hanzawa, 1922; Brady, 1875).

Occurrence.—Lower and upper members of the Shimoshiriwa Formation (SH 1 to SH 6 levels of Matsumaru et al., 1981).

Repository.—Saitama University Collection.

Nerepholidina praetournoueri H. Douville, 1925

Figs. 2-9—10

Nerepholidina praetournoueri H. Douville, 1925, p. 61, figs. 62-63; Lange, 1965, p. 57-59, pl. 1, fig. 1.

Lepidocyclina (Nerepholidina) tournoueri (Lemoine and R. Douville) var. praetournoueri (H. Douville). Brönnimann, 1940, p. 50-54, figs. 12a-c, 14a-c, p. 3, figs. 1-2.

Description.—Test small, lenticular in outline, 2.6 to 4.9 mm in diameter, 1.2 to 1.4 mm thick. Papillae small, better developed in central part, 100 to 110 μm in diameter, and heads of pillars traversing lateral layer of chambers. Embryonic chambers, consisting of two subequal protoconch and deuteroconch, being separated from each other by straight or slightly arched partition about 10 μm thick, and isolepidine type. Whole embryonic chambers measuring 434 to 438 μm in diameter across both protoconch and deuteroconch, and 367 to 494 μm at right angles to preceding. Protoconch semicircular, 315 to 378 μm in internal diameter and deuteroconch nearly reniform, 319 to 430 μm in internal diameter. Wall of embryonic chambers 20 to 35 μm thick. Adaxiliary chambers numbering from 3 to 4. Equatorial chambers arcuate through ogival to hexagonal or spatulate through ontogeny in equatorial section, polygonal or subcircular arrangement in equatorial section. Those near periphery being 84 to 112 μm in radial diameter, and 56 to 57 μm in transverse diameter; their height increasing gradually towards periphery, about 50 μm near center and about 135 μm near periphery. Lateral chambers arranged in a tier of 10 to 12 layers over center. Chambers over center and at periphery 110 to 130 μm long, 50 to 60 μm high, and floors and roofs 20 to 25 μm thick.

Remarks.—The present form resembles Lepidocyclina (Nerepholidina) tournoueri (Lemoine and R. Douville), 1904, described from northwest Morocco (Brönnimann, 1940), but the former is distinguished by having the isolepidine type nuleoconch. The present form is concordant to the description of H. Douville (1925, p. 61), and is assigned to Nerepholidina praetournoueri H. Douville.

Occurrence.—Lower member of the Shimoshiriwa Formation (SH 1 to 4 levels of Matsumaru et al., 1981).

Repository.—Saitama University Collection.

Nerepholidina sumatrensis (Brady) hanzawai

Matsumaru, n. subsp.

Figs. 2-11—15

Diagnosis.—A subspecies of the genus Nerepholidina with a nerepholidine-type bilocular apparatus, lozenge-shaped equatorial chambers in neionic stage near center, and spatulate or hexagonal in neanic stage, arranged in circular in neonic stage and polygonal in neanic stage in equatorial section.

Description.—Test small, with an inflated flat-topped central boss surrounded by a very thin rim, 3.8 to 5.0 mm in diameter, 1.9 to 2.2 mm thick. Eight to 10 papillae distributed over flattened apex of central area. Between papillae there is a faint polygonal mesh representing outline of lateral chambers. Embryonic chambers nerepholidine. Whole embryonic chambers attaining a 399 to 415 μm diameter across both protoconch and deuteroconch, and 406 to 435 μm at right angles to preceding.
Protoconch spherical, 218 to 280 μm in internal diameter, and deuteroconch reniform, 335 to 350 μm in inner diameter. Embryonic chambers ellipsoidal, 224 to 235 μm high in vertical section. Wall of embryonic chambers 25 to 45 μm thick. Adaxial chambers numbering from 4 to 6. Equatorial chambers lozenge-shaped and circular in arrangement in nepionic stage, and spateulate or hexagonal and polygonal arrangement in neanic stage through ontology in equatorial section. Chambers near periphery measuring 84 to 105 μm in radial diameter and 63 to 74 μm in transverse diameter; their height increasing gradually towards periphery to 120 to 160 μm. There are 13 to 15 open lateral chambers arranged in regular tiers on each side of equatorial layer at center of test. Lateral chambers at periphery and over center 220 to 270 μm long, 67 to 75 μm high. Pillars irregularly distributed in vertical section, less than 130 μm in surface diameter, but larger in central boss.

Remarks.—This subspecies is close to the one obtained for the description of Nephrolepidina sumatrensis (Brady) by Rutten (1911, 1914), Caudri (1939) and Cole (1953), and the vertical sections of these two forms appear to be inseparable. The Shimoshiroiwa form is, however, distinguished from Nephrolepidina sumatrensis in its predominant spateulate or hexagonal equatorial chambers and their prevalent polygonal arrangement in equatorial section. This present subspecies resembles specimens from Shimoshiroiwa figured by Hanzawa (1931b, p. 163, pl. 27, figs. 5–8) under the name L. (Amphilepidina) nipponica Hanzawa var. izuensis, but differs from the latter in its slender pillars. This subspecies is named in honor of Dr. Shoshiro Hanzawa.

Material.—Holotype, Saitama University Collection No. 890601 from loc. SH 3, equatorial thin section, showing the embryonic apparatus and equatorial chambers of nepionic to neanic stages through ontology. Paratype, No. 890602 from loc. SH 3, vertical thin section, showing the equatorial layer, lateral chamber layers and the distribution of pillars.

Occurrence.—Lower member of the Shimoshiroiwa Formation (SH 1 to 14 levels of Matsumaru et al., 1981).

Depository.—Saitama University Collection.

REFERENCES


1958: Names of and variation in certain American larger foraminifera.—no. 1, Ibid., vol. 36, no. 170, p. 179–204.


44–45.


