SCIENTIFIC CONTRIBUTIONS OIL AND GAS
Vol. 42, Number 2, August 2019: 5 of 5
RESEARCH AND DEVELOPMENT CENTRE FOR OIL & GAS TECHNOLOGY LEMIGAS
Journal Homepage:http://www.journal.lemigas.esdm.go.id
ISSN: 2089-3361, e-ISSN: 2541-0520

NEW SPECIES OF RADIOLARIA FROM THE ISLAND OF BUTON, SOUTH EAST SULAWESI

(Spesies Baru Radiolaria dari Pulau Buton, Sulawesi Tenggara)

Soemoenar Soeka (Ret)
(Ret) Group Stratigraphy, "LEMIGAS" R & D Centre for Oil and Gas Technology
Jl. Ciledug Raya, Kav. 109, Cipulir, Kebayoran Lama, P.O. Box 1089/JKT, Jakarta Selatan 12230 INDONESIA
Tromol Pos: 6022/KBYB-Jakarta 12120, Telephone: 62-21-7394422, Faxsimile: 62-21-7246150
E-mail: .....@esdm.go.id

First Registered on May, 3rd 2019; Received after Correction on July, 17th 2019
Publication Approval on: August 30th, 2019

ABSTRAK

Soeka (1991) melaporkan 30 spesies baru radiolaria, 3 genus baru, dan beberapa spesies yang tidak dapat dideterminasi dari Formasi Tobelo, Pulau Buton, Sulawesi Tenggara. Di antara spesies yang belum dideterminasi diusulkan sebagai spesies baru dan disampiakan dalam tulisan ini, sebagai berikut: 1. Actinomma panujui Soeka; sp. nov.; 2. Orbiculiforma eocenica Soeka; 3. Spongotrochus kholiqi Soeka, sp. nov.; 4. Spongotrochus buskamali Soeka, sp. nov.; 5. Spongotrochus iskandari Soeka, sp. nov.; 6. Sethodiscus (Sethodiscinus) imami Soeka, sp. nov.; 7. Lichnocanoma rasantyoi Soeka, sp. nov.; dan 8. Sethocapsa transitoria Soeka.

ABSTRACT

Soeka (1991) reported 30 new species of radiolarians, 3 new genera, and several undetermined species from the Tobelo Formation, Buton Island, South East Sulawesi. Among the undetermined spesies are proposed as new spesies and presented in this report. Those new species are: 1. *Actinomma panujui* Soeka; sp. nov.; *2. Orbiculiforma eocenica* Soeka; *3. Spongotrochus kholiqi* Soeka, *sp. nov.; 4. Spongotrochus buskamali* Soeka, sp. nov.; *5. Spongotrochus iskandari* Soeka, sp. nov.; *6. Sethodiscus (Sethodiscinus) imami* Soeka, sp. nov.; *7. Lichnocanoma rasantyoi Soeka,* sp. nov.; and *8. Sethocapsa transitoria* Soeka.

Keyword: Radiolaria, New taxa, Tobelo, Buton, Soeka Soemoenar.

How to cite this article:

Soeka, S., 2, 2019, NEW SPECIES OF RADIOLARIA FROM THE ISLAND OF BUTON, SOUTH EAST SULAWESI, *Scientific Contributions Oil and Gas*, 42 (2) pp, 73-84 DOI: 10.29017/SCOG. 42.2.73-84.

I. INTRODUCTION

Buton Island located in the Southeastern arm of South Sulawesi (Figure 1). Before 1991, radiolarian faunas from the Island of Buton had not been studied. Soeka, 1991 pioneered study of Jurassic (Pliensbachian-Toarcian) and Cretaceous (Valanginian) to Paleogene (Eocene-Oligocene) radiolarians. The Jurassic samples are collected from Ogena Formation, whereas the Cretaceous-Paleogene samples were collected from Tobelo Formation.

In 1991 Soeka proposed 1 subfamily Spongoacanthinae Soeka, 3 genera i.e. *Butonastrum* Soeka, *Paraxitus* Soeka and *Discoconocaryomma* Soeka,. Moreover 30 new species of radiolarians had been

found, and several undetermined species were reported. Those 30 species are:

01. *Butonastrum perkinsi* Soeka
02. *Triacticus tumidus* Soeka
03. *Zanola deweveri* Soeka
04. *Zanola riedeli* Soeka
05. *Praeconocayomma sutrismani* Soeka
06. *Sphaerostylus lukmani* Soeka
07. *Orbiculiforma eocenica* Soeka
08. *O. pseudolawreynsis* Soeka
09. *O. hasjimi* Soeka
10. *O. pseudomaxima* Soeka
11. *O. vargae* Soeka
12. *Paronaella extrema* Soeka
13. *P. wrighti* Soeka
14. *Emiluvina centraspinosa* Soeka
15. *Archaeospongoprunum bonai* Soeka
16. *A. cooki* Soeka
17. *Discoconocaryomma mudjitoi* Soeka
18. *Ristola sanfilippoae* Soeka
19. *R. bluefordae* Soeka
20. *R. nakasekoi* Soeka
21. *Sethocapsa conoidea* Soeka
22. *S. leiostracoides* Soeka
23. *S. transitoria* Soeka
24. *Syringocapsa martini* Soeka
25. *Cryptamphorella hispida* Soeka
26. *Novixitus carriei* Soeka
27. *N. wahjudii* Soeka
28. *Paraxitus wartonoi* Soeka
29. *P. subijantoi* Soeka
30. *Katroma zambellii* Soeka

On the basis of those undetermined species, this recent paper presents some of them as new species which belong to Suborder Spumellariina and Suborder Nassellariina that represent Cretaceous and Paleogene (Eocene-Oligocene) ages.

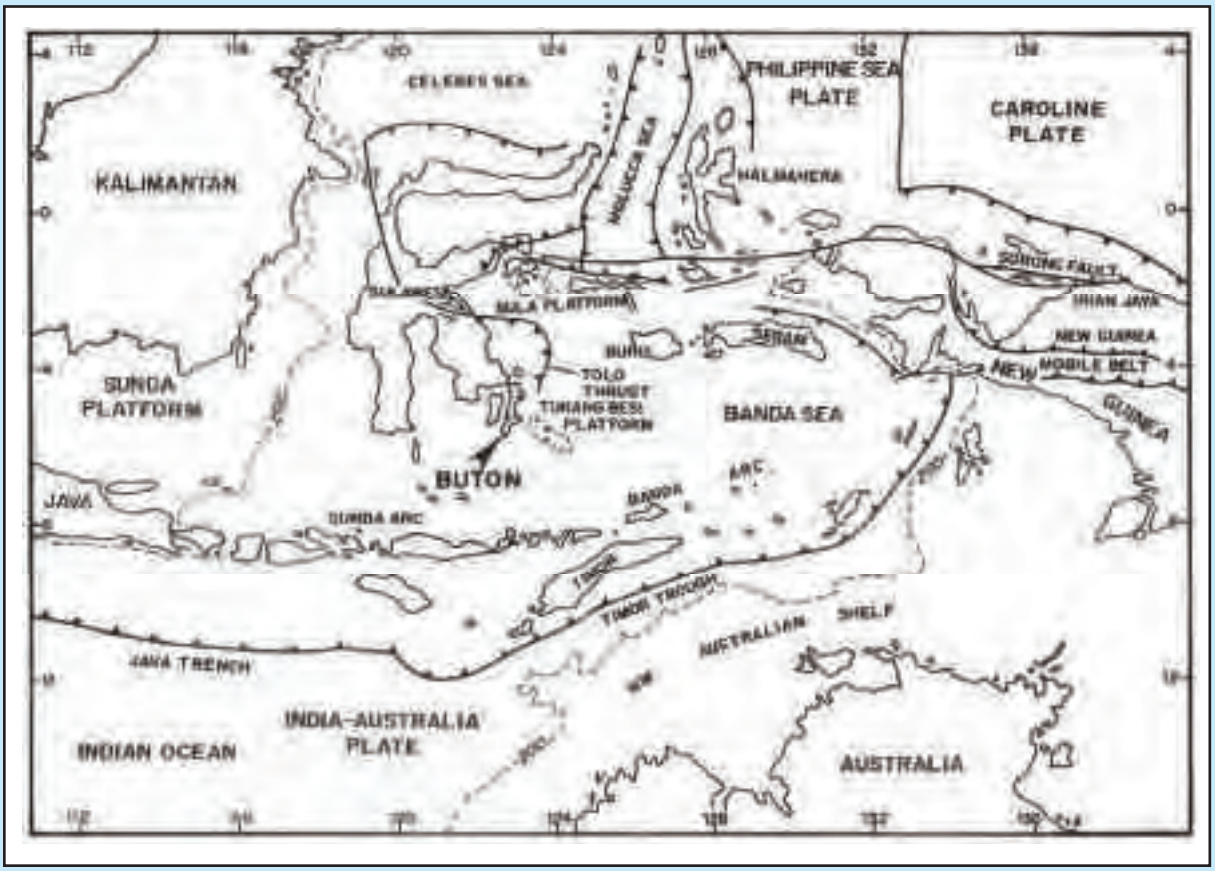

Figure 1
Geographic setting and tectonic features of eastern Indonesia (Smith, 1983).

Buton Island is part of Sula-Buton Province comprises terranes of Australian origin situated in or adjacent to eastern Sulawesi. The Sula-Buton Province is bounded to the west by the Western Sulawesi volcanic arc province and metamorphic-ophiolite belt of SE Sulawesi province (Figure 2).

Buton Island is primarily a westward-directed fold-thrust belt composed of Australian continental sediments imbricated with non-Australian Ophiolitic material. The imbricated sequences consist of ophiolite, metamorphic rocks and sediments of Australian affinity which range as young as Upper Oligocene, are grouped together as the Wolio Complex (Smith, 1983). These are overlain by syn to post orogenic sediments of Miocene-Recent age. It consists of a pre-Neogene carbonate sequences overlain by Neogene sediments (essentially marine sediments) and Quaternary reef limestones (Figure 3). Buton and Muna Islands are separated by the Buton Strait contains thick sequence of Neogene strata of more than 3000 m thick (Figure 3).

The new proposed sepecies taken from Waulala River Traverse South Buton and Tobelo River Traverse North Buton. Waulala section contain Ogena and Tobelo Formations (Figure 4) while Tobelo River (Figure 5) dominated by Tobelo Formation as locality type. The lithology of the Ogena Formation consists of well-bedded limestones, grey to light brown in colour. At the Ogena River area this formation consists of light grey, well-bedded, locally bitumineous and impregnated by asphalt.

Litholoy of Tobelo Formation consists of fine-grained. pink to rose-coloured limestone (calcilutite), usually unbedded, very hard, rich in planktic microfossils such as radiolarians, calcareous nannofossils, and foramminifers. Brownish red chert nodules are sometimes present in the formation; their sizes reach up to 55 cm in diameter. This formation is deposited within bathyal environment (Figure 3).

Radiolarian faunas indicate that there is no Paleocene age within Tobelo Formation. It is likely due to condensed section, deep sea erotion, or.no deposition; condensed section is the most likely.

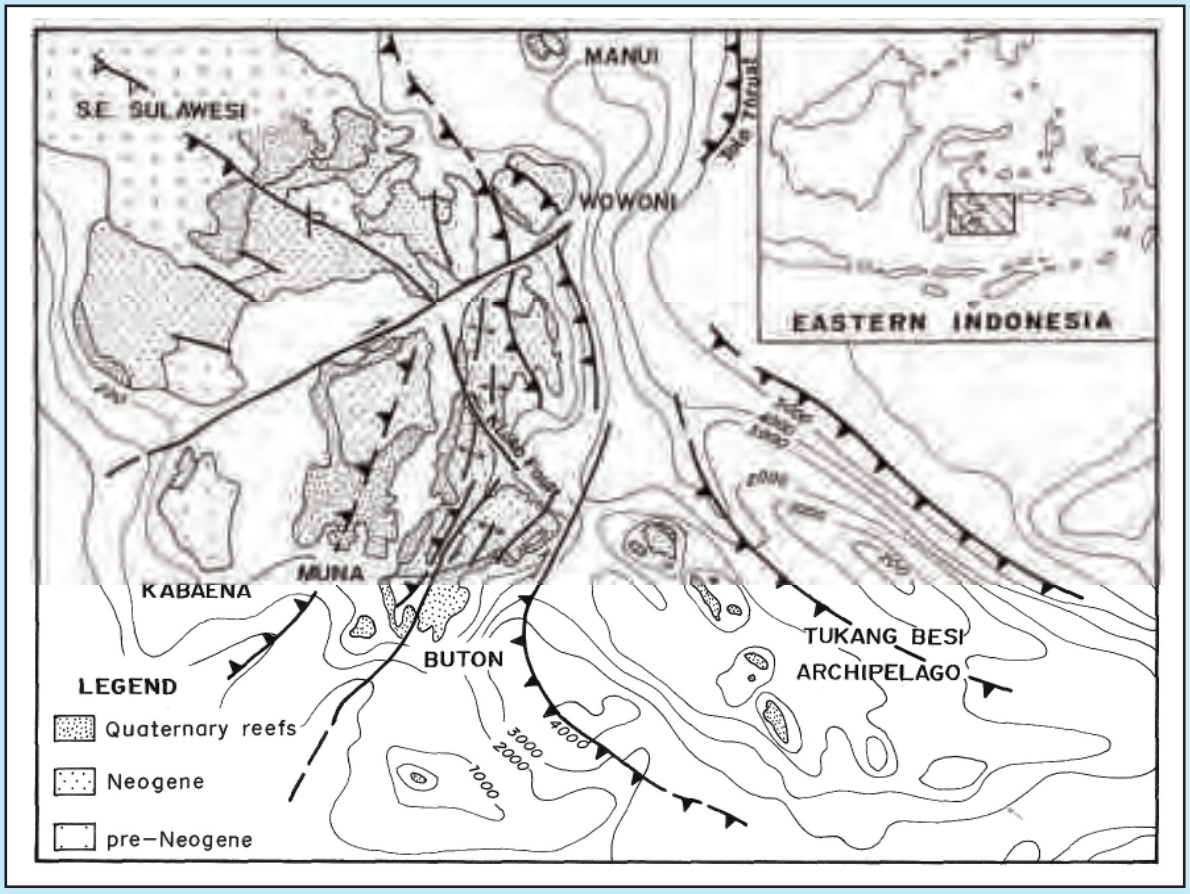

Figure 2
Schematic tectonic configuration of Buton and adjacent areas (modified from Van Marle, 1989).

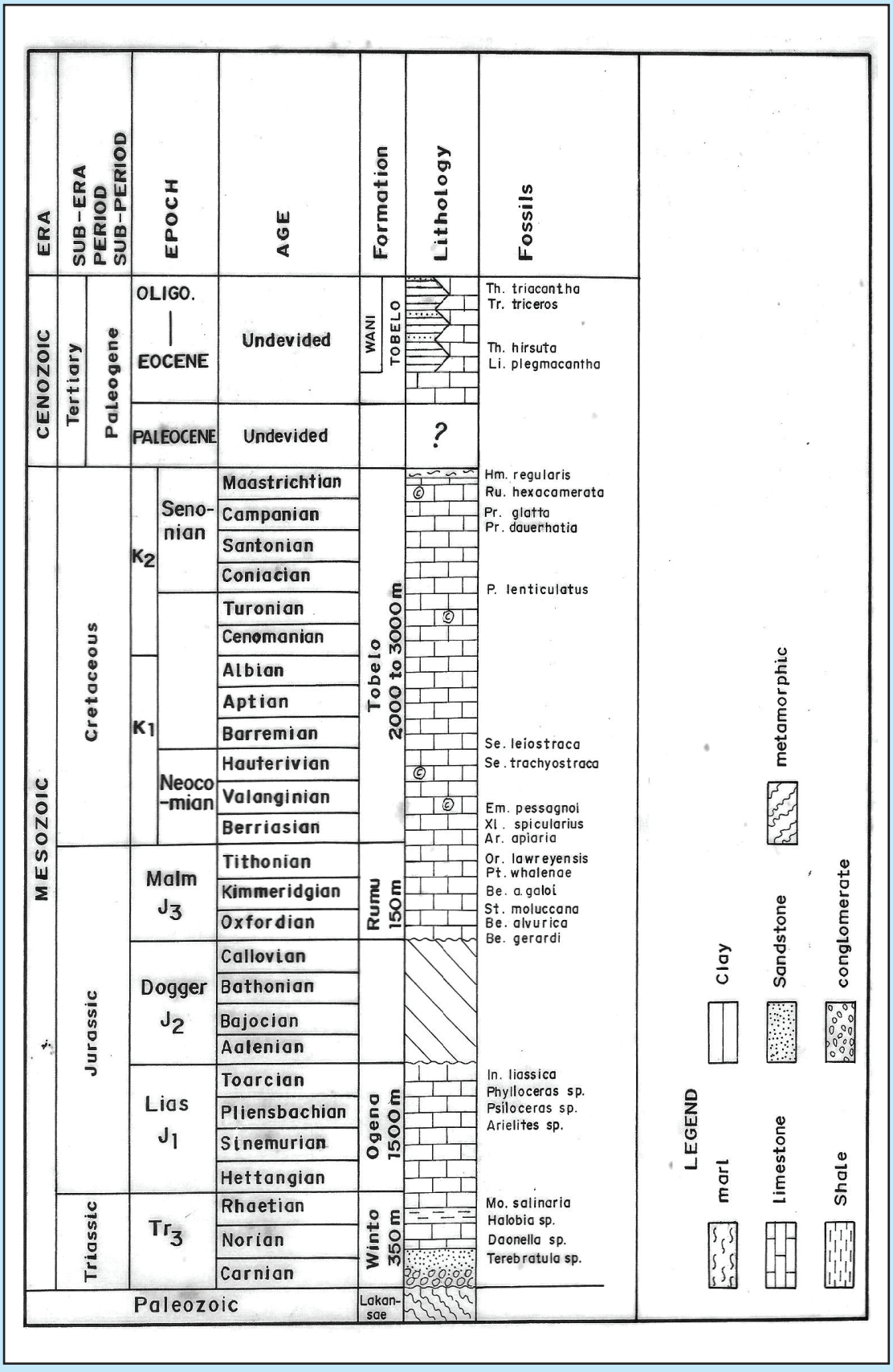

Figure 3
Prae-to early tertiary generalized stratigraphy column of Buton.

II. METHODOLOGY

Sedimentary rocks that crop out in the Waulala and Tobelo Rivers was sampled and prepared in the Laboratory using preparation technique follows that of Sanfilippo et al. (1971). The residu was Test morphology of each new species, either internal features or external features, are determined on the basis of combined Sanning Electron Micrograph (SEM) and Transmited Light Micrograph (TLM) methodes; however, only TLM features are presented in this paper.

III. RESULT AND DISCUSSION

The new proposed species belong to taxonomy: Phylum Protozoa Goldfus; Subphyllum Sarcodina; Class Actinopoda Calkins; Subclass Radiolaria Muller; Order Policystida Ehrenberg, emend, Riedel, 1967 and Suborder Spumellariina and Suborder Nassellariina.

A. *Spumellarians*

Spumellarians is radiolaria which consists only one cyrtid (segment), with varies in shape and size; several shapes suh as circular, triangle, quadriangle, and elongate. Stratigraphically this suborder appears for the firt time at Cambrian (Early Paleozoic) and still alive untill the Holocene (Recent).

1. *Actinomma panujui* Soeka, sp. nov. (Pl. 2,. fig. 9) 1991. *Actinomma sp. 2* **Soeka.**

Test subglobular in outline with three concentric lattice shells, bearing 12 radial spines. Pores large, rounded to subrounded, bigger than inter pore bars, more than 12 pores at the equatorial plane. Spines long, three-bladed with shallow grooves, sharp tips, maximum test diameter 124 µ.

The new species is named for Drs. Panuju, MT, nannofossils expert, Head of Exploration Division LEMIGAS for his kind cooperation to finish up LEMIGAS-PERTAMINA Joint Evaluation Study Report, Cepu Field (2005). Holotype Soeka Cllection BRC 4A8.(3.5), from sample WL 40, Tobelo Formatio, Waulala River aea, South Buton, Early Cretaceous (Valanginian).

2. *Orbiculiforma eocenica* Soeka. (Pl. 2, fig. 12) 1991. *Orbiculiforma eocenica* **Soeka, sp. nov.**

Spongy test, circular to subcircular in outline, with relatively shallow central cavity, 3 spines, triangular in cross section, with 3 alternating ridges and grooves, sharp tips, arrange asymmetrically. Meshwork massive, pores rounded, Test diameter (excluding spines) 299/150 µ, central cavity diameter 125/90 µ.

This new species is common within sample TB 13, from Tobelo Formation, Tobelo River area, Eocene of North Buton. Holotype Soeka Collection BRC 2C12 (8.9).

3. *Paronaella wrighti* Soeka, (Pl. 2, fig.4).

1991. *Paronaella wrighti* Soeka, sp.nov,
Three armed spongy test (sometimes with interbrachial veil), with inter-arm angle approximately 120 degree. Rays flat, dissimilar in length, approximately similar in width and shape. The distal end of each arm terminated with a prominent, conical central single spine flanked by two conical, short spines. Those spines are circular in cross section. Surface of each arm with four parallel rows of pores with weak longitudinal beams and transverse bars; pore rows do not join in the central area. Pores circular to elleptical in outline, if elleptical, the long axis of pores always parallel to the longitudinal beams.

Paronaella wrighti Soeka is ditinguishd from *Paronaella solanoensis* Pessagno by having flatter test with four rows of each arm.This species is abundant within sample WL 40 from Tobelo formation, Waulala River area, South Buton, Early Certaceous (Valanginian).

The new species is named for Prof. Anthony J. Wright of the Geology Departmen, the University of Wollongong, Australia for his kind supervision during preparation of the PhD. dissertation.

4. *Spongotrochus kholiqi* Soeka, sp.nov. (Pl. 1, fig.7) 1991. *Spongotrochus* **sp 6 Soeka**

Spongy, 130 µ test with a single medullary shell, disc-shaped in general view, surface smmooth, bearing radial spines. Pores well distributed, uniform, circular to elleptical in form, 8-10 pores on the radius of test, 16 three bladed radial spines.

Spongotrochus kholiqi is distinguish from *Spongotrochus* sp. 3 by having 16 radial spines raher than 15, and larger pores marginally.This species is rare within sample WL 40. Because the specimen is not well cleened, lacking marginal spines, the character of radial spines is unknown. This new species is named for Drs. Abdul Kholiq, foraminiferal paleontologist from LEMIGAS who gave a good cooperation to finish up and as co-author of scientific contribution entitle *The Indonesian Cenozoic Planktic Foraminifers: their Classification and*

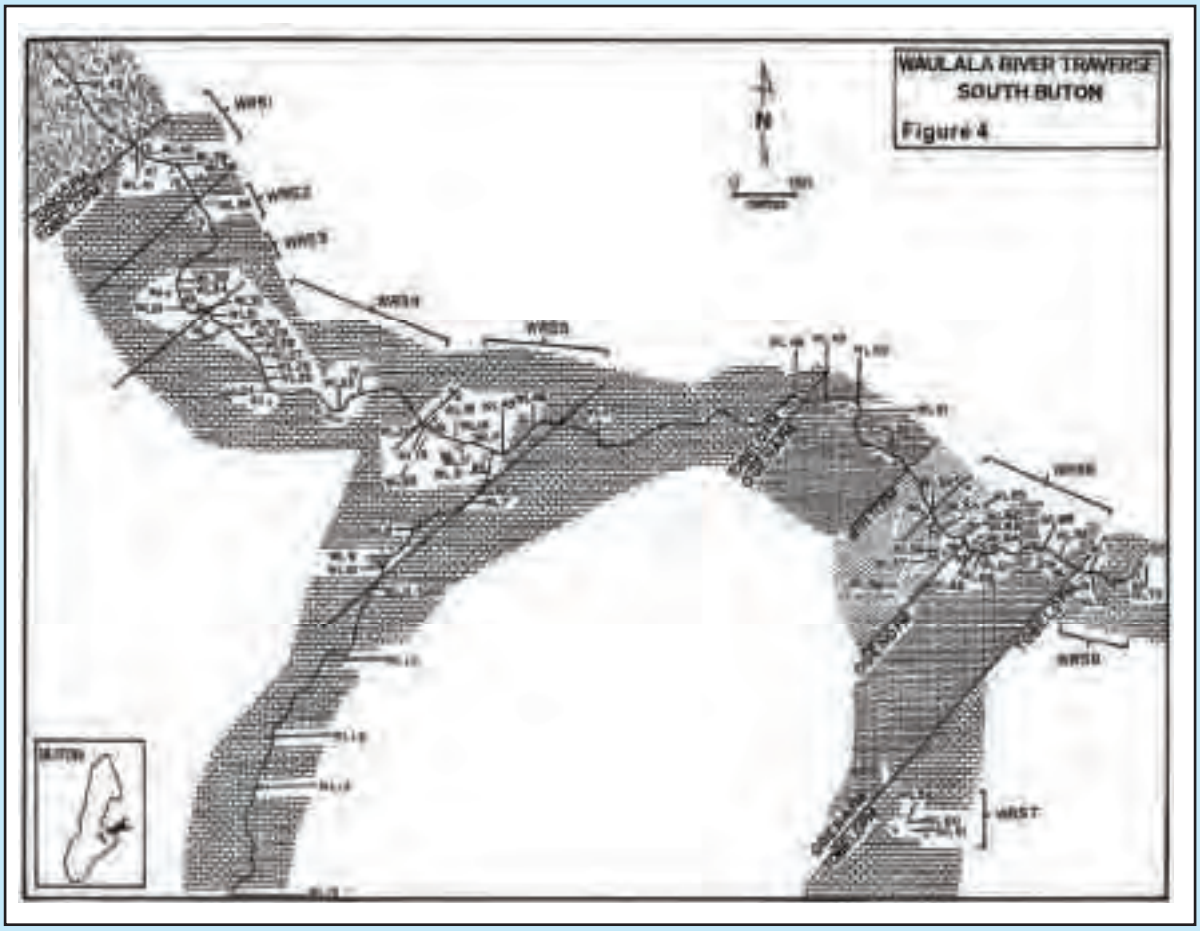

Figure 4
Waulala river traverse south Buton.

Occurrences (1997). Holotype Soeka Collection BRC 10B9 (16.9); sample WL 40 of the Early Cretaceous (Valanginian) Tobelo Formation, South Buton.

5. *Spongotrochus buskamali* Soeka, sp. nov. (Pl. 2, fig. 2) 1991. *Spongotrocus* **sp. 4 Soeka**

Test spongy, circular discoidal with marginal radial spines, Meshwork very fine, pores irregular in size and form, Radial spines fall into 2 groups based on size and form. The first type is large, long, three-blladed with ridges an grooves, sharp tips. The second one is smaller, elongate, imperforate, circular in cross sedtion, sharp tips. The bladed spines are always bigger than unbledded spines.

Spongotrochus buskamali is easily distinguished from other *Spongotrochus* by having two kinds of radial spines (bladed and unbladed) rather than only one kind of bladed radial spines.The maximum diameter is 150 µ.

This species is named for Ir. Buskamal, nannofossil expert from LEMIGAS for his kind cooperation within the group Holotype Soeka Collection BRC 3E11 (16.4), sample WL 40 from Waulala River area, South Buton, Early Cretaceous (Valanginian).

6. *Spongotrochus iskandari* Soeka, sp. nov. (Pl. 2, fig. 6) 1991. *Spongotrochus* **sp. 2. Soeka**

Test spongy, circular to discoidal in general view, with radial marginal spines, Meshwork fine, with circular or subcircular to irregular pores. Four prominent radial spines perpendecular to another one, long, imperforate, sharp tips, circular in cross section.

Only two specimens are found in the study area but their preservation is good. The average length of maximum diamater is 111 µ; the average length of radial sines is 68 µ. The new species is named for Ir. Iskandar from Stratigraphy Group

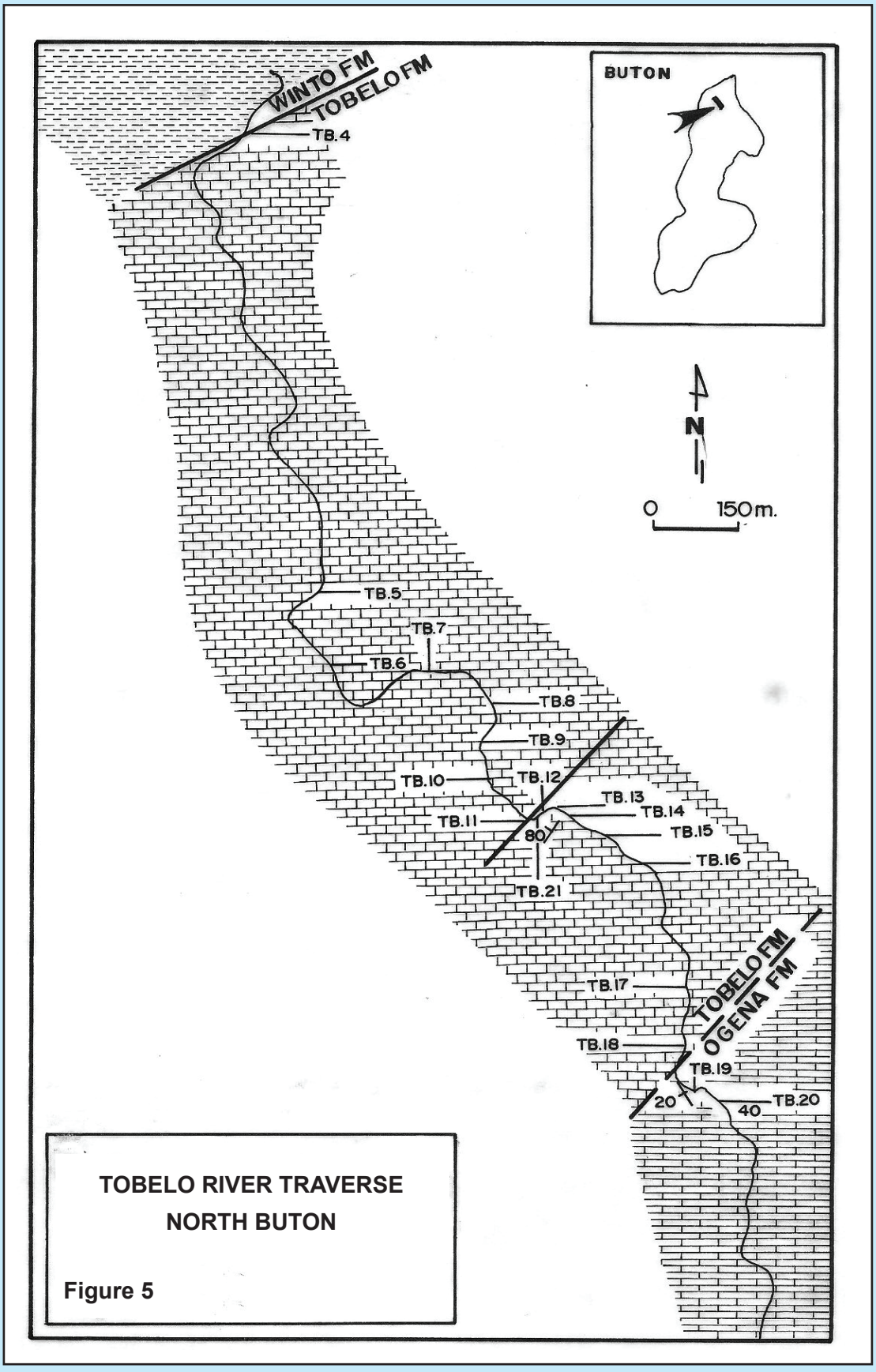

Figure 5
Tobelo river traverse north Buton.

of LEMIGAS for his good cooperation within the group. Holotype Soeka Collection BRC 3E7 (14.6), BRC 3E8 (14.8), sample WL 40, from Tobelo Formation, Waulala River area, South Buton, Early Cretaceous (Valanginian).

7. *Sethodiscinus (Sethodiscinus) imami* Soeka, sp. nov. (Pl. 1, fig. 2) 1991. *Sethodiscinus* **sp. 2, Soeka**

Test simple, disc-shaped in general view, with single medullary shell, lacking marginal spines and equatorial girdle. Pores uniform in shape and size, circular with hexagonal pore frames. This new species is named for Drs. Imam Prayitno, nannofossil expert, head of Stratigraphy Group, LEMIGAS for his kind cooperation and communication within the group. *Sethodiscinus (Sethodiscinus) imami* differs from *Sethodiscinus (Sethodiscinus)* sp. 1 by havig disc-shaped rather than flat to weakly disc-shaped. Holotype Soeka Collection BRC 8C1 (4.5), BRC BC2 (4.6) from sample WL 35, Tobelo Formation, Waulala River Area, South Buton, Oligocene.

B. *Nassellarians*

Nassellariina is radiolaria which their tests consists of 2, 3 or more segments (multi cyrtids) that are named as cephalis, thorax, abdomen, and post abdominal segment. Cephalis bears imperforate apical horn. Stratigraphically this suborder ranges from Triassic (Mesozoic) up to Holocene.

1. *Lichnocanoma rasantyoi* Soeka, sp. nov. (Pl. 2, fig. 1) 1991. *Lihnocanoma* **sp. 1, Soeka, Pl. 2, fig. 1.**

Test lattice, broadly conical, bell-shaped; 2 segments (cephalis and thorax); collar stricture sharp. Cephalis subspherical, very short (not more than 0.2 % length of the test), imperforate, slightly asymmetrical, its basal diameter greater than its altitudes, with a short apical conical horn; base as wide as long, not porous. Thorax dome-shaped, its greatest diameter at or near the middle of thorax, symmetrical, with well-spaced, subspherical pores. Three basal feet, bladed, equidistsnt, strong, divergent, convex outwardly. Basal mouth rounded, wide, open. Horn length 18 µ, cephalis length 23 µ, cephalis width 29 µ; thorax length 76 µ, width 94 µ, basal feet average 218 µ.

Holotype Soeka Collection BRC 7B11 (27.6); sample TB 21 from Tobelo River, North Buton, Eocene. The new species is named for Ir. Tri Bambang Sukmo Rasantyo, MT, palynology expert, Group of Stratigraphy for his good cooperation to finish up the study of LEMIGAS-LAPINDO BRANTAS Joint Study, Carat-Wunut-Tanggul Angin Fields, North East Jawa Basin.

2. *Sethocapsa transitoria* Soeka (Pl. 2, fig. 7) 1991. *Sethocapsa transitoria* **Soeka, sp. nov.**

Test of four segments (cephalis, thorax, abdomen, and post abdomenal segment), pyramidal in outline, globular terminal segmet lacks basal aperture; strictures not well-developed, development of first to second segment, and the second to thirth segment is gradual, whereas the development of third to last segment is abrupt. Cephalis is smallest segment, poreless, circular in transverse section, bears apical horn, sharp, circular in transvers section. Thorax circular in transverse section, bears very small pores, circular to elleptical in forms, Abdomen perforate, without nodes. The biggest terminal segment globular, bears rounded to subrounded pores, without pore frames. Spines sturdy, elleptical in transverse section, sometimes with shallow grooves.

The average total length 218 microns, length of proximal part (cephalis + thorax + abdomen) 100 µ, diameter terminal part 106 µ; segment width 136 µ.

Holotype Soeka Collection BRC 2A3 (23.9) from sample WL 40, Waulala River, South Buton, Valanginian.

***3. Alievium helenae* Schaaf** (Plate 2, figure 11)

4. *Amphicraspedym prolixum* Sanfilipo and Riedel (Plate 2, figure 8)

5. *Heliodiscus cf. H. heliastericus* Clark and Campbell (Plate 1. figure 1)

6. *Lithociclya angusta* (Riedel) (Plate 1, figure 5-7)

7. *Lithocyclia aristotelis* (Ehrenberg) ((Plate 1, figure 8-9)

8. *Spongatractus pachystilus* (Ehrenberg) (Plate 2, figure 1-2)

C. *Spumellarians Incertae Sedis*

1. *Butonastrum* Soeka 1991. *Butonastrum* **Soeka, gen. nov.**

Type species: *Butonastrum perkinsi* Soeka

Four-armed test with or without single central spine at each arm. Central area without medullary

Plate 1

Figs. 1-2. *Heliodiscuc cf. H. heliastricus* Clark and Campbell

Fig. 3. *Sethodiscinus (Sethodiscinus) imami* Soeka, sp. nov.

Fig. 4. *Butonastrum perkinsi Soeka*

Figs. 5-7. *Lithocyclia angusta* (Riedel)

Figs. 8-9. *Lithocyclia aristotelis* (Ehrenberg)

Figs. 10-11. *Discoconocaryomma mudjitoi* Soeka

Fig. 12. *Songotrochus kholiqi* Soeka, sp. nov.

Plate 2

1-2. *Spongatractus pachystylus* (Ehrenberg)

3. *Tritrabs ewingi* (Pessagno)

4. *Paronaella wrighti* Soeka

5.. *Lychnocanoma rasantyoi* Soeka, sp. nov.

6. *Spongotrochus iskandari* Soeka, sp. nov.

7. *Sethocapsa trasitoria* Soeka, sp. nov.

8. *Amphicraspedum prolixum* Sanfilippo and Riedel

9. *Actinoma panujui* Soeka, sp. nov.

10. *Spongotrochus buskamali* Soeka, sp. nov.

11. *Allevium helenai* Schaaf

12. *Orbiculiforma eocenica* Soeka

shell. Arm cylindrical, elongate, circular to subcircular in cross section. Surface of rays with linear to sublinear arragement of pores.

This new monospecific genus is distinguish from *Hagiastrum* by lacking medullary shell, longitudinal beam and traverse bar; and from *Staulastrum* Haeckel, 1887 by lacking a central simple chamber which is surrounded by concentric rings. *Butonastrum* differs from *Crucidiscus* by having a smaller central area and longer porous arms.

2. *Butonastrum perkinsi* Soeka, (Pl. 1, fig. 3) 1991. *Butonastrum perkinsi* **Soeka, gen.et.sp.nov.**

Test lattice, four armed, with single central spine at each arm. Central area without medullary shell. Arms cylindrical, elongate, composed of 6 pore rows with linear to sublinear arragement. Pores rounded, elleptical to quadriangular; if elleptical or quadriangular parallel to the long axis of the arm. Central spine short, cylindrical, imperforate; the average length of arms (without spines) 81,75 µ. The central spines are mostly broken.

Holotype (Soeka Collection BRC 6B6 (2.5) from the Eocene Tobelo Formation, Waulala River, North Buton; sample TB13. The name of this new species is dedicated to Mr. Max Perkin from geology department, the University of Wollongong in honor of his good cooperation during my study at the university. This new species is common in the sample TB 13 of North Buton and preservation is good.

3. *Discoconocaryomma* Soeka, 1991. *Discoconocaryomma* **Soeka, gen. nov.**

Type species: *Discoconocaryomma mudjitoi* Soeka.

Latticed spumellarians, disc-shaped in general view, without medullary shells, lacking radial spines. SEM indicates surface of the test bears mammae, each mamma having one pore situated at the top of the mamma and encircled by other pores; pores regular, of similar size, rounded to subrounded.

This new genus is distinguished from *Praeconocaryomma* Pessagno by having a dis-shaped rather than globular test; and differs from *Cenodiscus* by having mammae. The genus can not be placed in the Praeconocaryommidae since the test is discoidal without medullary shells; moreover it can not be placed in the Cenodiscinae since the test possesses mamae.

4. *Disconocaryomma mudjitoi* Soeka (Pl. 1, figure 6) 1991. *Discoconocaryomma mudjitoi* **Soeka, gen. et sp.nov.**

Transmitted Light Micrograph indicates disc-shaped, latticed, lacking both medullary shells and radial spines. Scanning Electron Micrograph indicates test bears mammae, moderately high in relief; each mamma bears 7 circular to subcircular pores. One pore is situated at the top of each mamma, and encircled by 6 pores. Pores regullar, nearly similar in size, without well-developed hexagonal pore frames. Average diameter of the test 222 µ, test tickness 157 µ.

This new species is abundant within Cretaceous and Eocene samples and preservation is good. The name of the new species is didicated to Dr. Ir. Mudjito of LEMIGAS in honor of contribution to the understanding of pre-Tertiary geology of the island.

Holotype Soeka collection BRC 984 (19.1); sample WL 30, from Early Cretaceous to Oligocene of Tobelo Formation, Waulala River, South Buton.

IV. CONCLUTIONS

Based on those undetermined species, there are some new species which belong to Suborder Spumellariina and Suborder Nassellariina that represent Cretaceous and Paleogene (Eocene-Oligocene) ages. Those new species are: 1. *Actinomma panujui* Soeka; sp. nov.; *2. Orbiculiforma eocenica* Soeka; *3. Spongotrochus kholiqi* Soeka, *sp. nov.; 4. Spongotrochus buskamali* Soeka, sp. nov.; *5. Spongotrochus iskandari* Soeka, sp. nov.; *6. Sethodiscus (Sethodiscinus) imami* Soeka, sp. nov.; *7. Lichnocanoma rasantyoi Soeka,* sp. nov.; *8. Sethocapsa transitoria* Soeka.

ACKNOWLEDGMENTS

Special thanks to Prof. Anthony J. Wright of the Geology Departmen, the University of Wollongong, Australia for his kind supervision during preparation of the PhD. Dissertation, Lemigas and tim who support field work.

REFERENCES

Baumgartner, P. O., 1984. *A Middle Jurassic-Early Cretaceous low-latitude radiolarian zonation based on unitary associations and age of Tethyan radiolarits. Eclogae Geologicae Helvetiae*, 77 (3), 729-837.

Campbell, A. S. and Clark, B. L., 1944. *Radiolaria from Upper Cretaceous of middle California*. Geological Society of America Special Paper, 57, 1-61.

Clark, B. L..and Campbell, A. S., 1942. *Eocene radiolarian faunas from Mt. Diablo Area, California*. Geological Society of America Special paper , 39, 1-112.

Hetzel, W. H., 1928. *Geological Descripton of the Island of Buton*. Internal Report Geological Research and Development Cenetr Number S 81, 1-18.

Hinde, G. J., 1900. *Description of fossil Radiolaria from the roks of Central Borneo*. In Molengraff, G. A. F., (eds..), Borneo-Expeditie; Geologische Verkeningstochten in Central Borneo (1838-94), 1-51, 54-56.

Riedel, W. R. and Sanfilippo, A., 1971. *Cenozoic Radiolaria from Western tropical Pacific Leg,. 7*, In Winterer, E. L, Ridel, W. R., et al. (eds), Initial Reports of the Deep Sea Drilling Project, VII. 1529-1672

Sikumbang, N. dan Sanyoto, P., 1981. *Peta Geologi Lembar Buton dan Muna*. *Laporan Terbuka Puslitbang Geologi, Bandung.*

Smith, R. B., 1983. *Sedimentology and Tectonics of a Miocene Collision Complex and Overlying Late Orogenic Strata, Buton Island*, Eastern Indonesia. *Ph.D. Dissertation, University of California, Santa Cruz, U. S. A.* (unpublshed).

Soeka, S., 1988. *Late Jurrasic (Pliensbachian-Toarcian) Radiolaria fom Buton Island, Indonesia*. Paper presented at N. Z. Radiolarian Workshop 1988, the University of Auckland, Auckland, New Zealand, 1-25..

Soeka, S.,1991. *Radiolarian Faunas from the Tobelo Fomation. of the Island of Buton, Eatern Indonesia*, Ph.D. Dissertation (unpublished), Department of Geology, the University of Wollongong, NSW Australia, 1-398, text pls. 1-35, pls. 1 – 35.

Soeka, S. and Mudjito, 1992. *Early Cretaceous to Paleogene Bistratigraphy from the Microcontinent of Buton, Eastern Indonesia*. 29th International Geological Congress (IGC), Kyoto, Japan

Soeka, S., 1997. *Jurassic-Paleogene Paleolatitudes of Buton (Indonesia) as indicated by Radiolaria*; LEMIGAS Scientific Contibution Magazine.

Soeka, S., Ongkosongo, O. S. R, Natsir, S. M, dan Helfinalis, 2008. Biostratigrafi dan Penelusuran Evolusi Posisi Lintang Pulau Buton Sejak Mesozoikum dengan Radiolaria. Prosiding Seminar Nasional Ilmu Kebumian 2008, D11-1 – D11-15.

Tan Sin Hok, 1927. *Over de samenstelling et het onstaan van krijten mergel-gesteenten van de Molukken*. Jaarboek van het Mijnwezen in Nederlandsch-Indie, Jaargang 55, 1926, Proceedings, 3rd part, 5-165.

van Marle, L. J., 1989. Benthic Foraminifera from the Banda Arc Region, Indonesia and their paleobathimetric significance for geologic interpretation of the Late Cenozoic Record.. Academisch Proefscrieft, Vrije Universiteit, Amsterdam, 1-271.

Yeh, Kuei-Yu., 1987. *Taxonomic Studies of Lower Jurrasic Radiolaria from East-Central Oregon*. National Museum of Natural Science, Taiwan, Republic of China, Special Publication 2, 1-169, pls. 1-30.