The Triassic Marine Biota of Eastern Indonesia and its Interregional and Global Correlation: A Review

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Abstract

The interregional and global correlation of the Triassic biota of Indonesia was based on the review of previous workers and the author himself. Scythian Epoch (Early Triassic) in Timor is subdivided into Early Scythian with *Ophiceras demisso, Meekoceras* sp., *Pseudomonotis subaurita, Gervillia subpannonica,* and *Myophoria* sp., whilst Late *Scythian* is indicated by the presence of *Owenites egrediens* and *Sibirites* sp. The presence of Anisian Stage (Middle Triassic) in Misool is indicated by ammonite *Beyrichites* and bivalve *Daonella lilintana.* In Timor, this stage is pointed out by the presence of *Joannites cymbiformis, Monophyllites wengensis, Protrachyceras archaelus, Daonella indica, Tracyceras* cf. *aon, Brochidium timorense,* and *Lima subpunctatoides*. *Terebellina mackayi* found above *Beyrichites*-bearing bed in Misool has an age range from Anisian to Ladinian. It is concluded that the boundary between Anisian and Ladinian lies between beds with *Beyrichites* and *Terebellina mackayi*. Early Carnian Stage (Late Triassic) in Timor is indicated by the presence of *Joanites cymbiformis, Waldhausenites* sp., *Miltites* sp., and *Halogyra cipitiensis*; whereas Late Carnian is indicated by the presence of *Cladicites crassestriatus* and *Tropites subbulatus*. The presence of *Halobia verbeeki, Pinacoceras parma, Neobetites* sp., *Parabetites* sp., *Malayites* sp., *Amarassites* sp., *and Halorites* sp., indicates the Early Norian Stage, whilst the presence of *Cladiscites tornatus, Cyrtopleurits malayicus,* and *Trachypleuraspidites* sp. implies the Late Norian. The Rhaetian Stage in Timor contains *Choristoceras indoaustralicum,* whereas in Misool it contains *Choristoceras* sp. and *Cochloceras* sp.

Keywords: Triassic, biota, macrofossil, Scythyan, Anisian, Carnian, Norian, Rhaetian

Sari

Korelasi interregional dan global pada biota laut yang berumur Trias di Indonesia dilakukan dengan metode penelaah hasil penelitian penulis-penulis terdahulu dan hasil penelitian penulis. Zaman Scythian (Trias Awal) di Timor dapat dibagi dua, yaitu Scythian Awal yang ditandai dengan keterdapatan fosil Ophiceras demisso, Meekoceras sp., Pseudomonotis subaurita, Gervillia subpannonica, dan Myophoria sp; sementara Scythian Akhir ditandai oleh keterdapatan fosil Owenites egrediens dan Sibirites sp. Jenjang Anisian (Trias Tengah) di Misool ditentukan oleh kehadiran fosil amonit Beyrichites dan bivalvia Daonella lilintana, sedangkan di Timor, jenjang ini ditandai oleh adanya fosil Joannites cymbiformis, Monophyllites wengensis, Protrachyceras archaelus, Daonella indica, Tracyceras cf. aon, Brochidium timorense, dan Lima subpunctatoides. Terebellina mackayi di Misool ditemukan di atas lapisan yang mengandung Beyrichites, dan umurnya berkisar mulai dari Anisian sampai Ladinian. Dengan demikian, batas antara jenjang Anisian dan Ladinian terletak di antara lapisan yang mengandung Beyrichites dan Terebellina mackayi. Jenjang Karnian Awal (Trias Akhir) di Timor ditandai oleh keberadaan fosil Joanites cymbiformis, Waldhausenites sp., Miltites sp., dan Halogyra cipitiensis. Sementara itu Karnian Akhir ditandai oleh Cladicites crassestriatus dan Tropites subbulatus. Jenjang Norian Awal dicirikan oleh adanya Halobia verbeeki, Pinacoceras parma, Neobetites sp., Parabetites sp., Malayites sp., Amarassites sp., Halorites sp., sedangkan jenjang Norian Akhir mengandung Cladiscites tornatus, Cyrtopleurits malayicus, dan Trachypleuraspidites sp.. Jenjang Rhaetian di Timor ditandai dengan adanya fosil Choristoceras indoaustralicum dan di Misool oleh Choristoceras sp. dan Cochloceras sp.

Kata kunci: *Trias, biota, fosil makro, Scythyan, Anisian, Karnian, Norian, Rhaetian*

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Introduction

The Mesozoic marine biota of Indonesia is widespread, and very diverse, because Indonesian Archipelago is composed of different tectonic fragments. Consequently, this region has one of the most complex geomorphic, paleontologic, and geologic development patterns in the world. The paleontological study reports of Indonesia are scattered in the libraries which need to be reviewed and lumped together in a synopsis. This paper is also based on the opinion that the Pre-Tertiary rocks of Indonesia have long been regarded as generally lacking in economic prospect. This effort is expected to be useful for a further study of Indonesian paleontology in the future.

The basement of the sedimentary basins consists of continental and oceanic terranes of incompletely known ages. Radiometric ages for metamorphic and mafic basement rocks are limited and become unreliable for older epoch, because of alteration and repeated metamorphism by tectonic events. The most acceptable dating for those rocks is therefore based on their stratigraphic position relative to fossil-bearing beds. Biostratigraphy is therefore very important in terranes analyses. As structure studies have progressed, particularly in the present era of the concept of plate tectonics, paleontologic and stratigraphic data have taken on even greater correlative and interpretive significance.

Biostratigraphy of the region is very much influenced by this highly mobile zone including the Tertiary-Quaternary Period. The Pre-Tertiary macrofauna has been found to be quite diverse and dominated by molluscs, especially bivalves, and cephalopods, with subsidiary brachiopods, corals, annelids worms, and crinoids. The accompanying microbiota has been largely untouched, although a few biostratigraphic information about the Pre-Tertiary rocks is that they have long been regarded as generally lacking economic prospects.

Methods

This paper is mainly based on the results of the paleontologic study of previous workers and the author himself. In some cases the geological data description and documentation of the occurrences of the Triassic biota have been attempted. These efforts are to establish the faunal succession and biostratigraphy in order to correlate the biota with the international standard chronostratigraphy and with another well known biostratigraphic scheme, and thereby to determine precise ages for the various Triassic faunal assemblages. It is hoped that this review will provide additional information and understanding the geology of the area.

The stages in Mesozoic Era are studied more comprehensively in Indonesia. Misool Archipelago is the only place where the Mesozoic rocks are well exposed bearing almost complete stages *e.g.* Triassic (Scythian to Rhaetian) strata. This paper summaries what is known of these marine biota of the Triassic age, based on the previous studies in the eastern part of Indonesia.

Previous Studies

Attention to the eastern part of Indonesia has long been carried out, especially on the Triassic biota, as follows:

Boehm (1904) reported the presence of *Daonella*-bearing slate of Triassic age here and in 1908, this author thought that some brachiopod species were of possibly Triassic or even Late Paleozoic age. Frech (1905) concluded that *Daonella* from Misool was similar to the European specimens, while Renz (1905) regarded that the *Daonella* was similar to the specimen from Sumatra and could link with Caledonian Triassic. Wanner (1907) (1910a,b) described the bivalve from this area as *Daonella lilintana*.

Bülow (1915) described Orthoceratidea and Belemnitidae from Timor. Arthaber (1927) reported the presence of *Ammonoidea leiostraca* of Late Triassic, and Diener (1923) described the *Ammonoidea trachyostraca* of Middle and Late Triassic in Timor. Bather (1929) described Triassic Echinoderms from this island. Gerth (1915, 1927) reported the *Heterastridium* from this area. Kieslinger (1924) described Nautiloids from Middle and Late Triassic from Timor. Kobayashi and Tamura (1968) redescribed bivalve *Myophoria* (*s.l.*) with a note on the Triassic Trigoniacea in Malaya. Krumbeck (1924) discussed some brachiopods, bivalve, and gastropods of Triassic from Timor. Kummel (1968) re-examined the ammonoids from Early Triassic of Timor. Vinasa de Rigny (1915) examined the Triassic algae, sponge, anthozoa, and bryozoa from Timor. Wanner (1907) described the Triassic fauna from Maluku and Timor Islands, and then in 1911 he also described the cephalopods from Timor and Rote Islands. Welter (1914, 1915, 1922) discussed the cephalopods from Timor. Ishibashi (1975) studied some Triassic ammonites from Indonesia and Malaysia.

In 1905, Boehm discussed the presence of brachiopods in the limestone from the Ambon Island; whilst in this island, Jaworski (1927) studied the Late Triassic brachiopods. Previously, in 1892 Rothpletz studied the fauna of Permian, Triassic and Jurassic formations from Timor and Rote Islands.

Seidlitz (1913) described the presence of brachiopod athyrids in the Buru and Misool Archipelagoes. Jaworski (1915) compared the Triassic fauna of Lios Member from this area with Europe and other parts of Indonesia. He has also described the Mesozoic biostratigraphy of Misool Archipelago including the Triassic sequence in the area. The Mesozoic biostratigraphy of Misool Archipelago is known as the most complete in South East Asia. Then in 1991, Hasibuan proposed stratigraphic and biostratigraphic frameworks of Mesozoic rocks of the Misool Archipelago. Hasibuan & Grant-Mackie (2007) discussed and described some Triassic and Jurassic gastropod from the Misool area and concluded that molluscan fauna is quite diverse, especially bivalves, gastropods, with the subsidiary brachiopods, corals, annelid worms and crinoid.

Hasibuan (2007a) studied the Pre-Tertiary rocks of Rote Island and based on the stratigraphic position of *Halobia* spp. and *Monotis (M.) salinaria*, he concluded that the Aitutu Formation of Late Triassic age has been overturned. He also found that the exposures of Triassic rocks in the area are more widely distributed than had been mapped by previous geologists (Rosidi *et al*., 1996).

Triassic Period

Tozer (1967,1984) revised the Triassic System in Germany and divided the Triassic Period into Scythian Epoch (Early Triassic: with Griesbachian, Nammalia and Spathian Stages), Middle Triassic Epoch (Anisian and Ladinian Stages), and Late Triassic Epoch (Carnian, Norian, and Rhaetian Stages). The scheme of the Triassic Period is later completed by Harland *et al*. (1989) (Table 1) described as below.

The Griesbachian (lower) is divided into Gangetian Substage (lower) with *Otoceras concatum* (lower) and *Otoceras boreale* (upper) biozones. Ellesmarian Substage (middle) above the Gangetian Substage has *Ophiceras commune* (lower) and *Proptyhites strigatus* (upper) biozones. Nammalian Stage is divided into Dienerian Substage (lower) with *Proptychites candidus* (lower) and *Vavilovites sverdrupi* (upper) biozones; the Spathian Stage (upper) above the Nammalian Stage has *Olenikes pilaticus* (lower) and *Keyserlingites subrobustus* (upper) biozones.

Middle Triassic: Anisian Stage (lower) is divided into Aegean Substage (lower) with *Lenotropites caurus* biozone, Pelsonian Substage with *Anagymnotoceras varium* biozone, and Illyrian Substage with *Frechites deleeni* (lower) and *Frechites chischa* (upper) biozones. Ladinian Stage (upper) is divided into Early with *Eoprotrachyceras subasperum* (lower), *Progonoceratires poseidon* (upper) biozones, and Late with *Meginoceras meginae* (lower), *Maclearnoceras maclearni* (middle) and *Frankites sutherlandi* (upper) biozones.

Late Triassic: Carnian Stage (Lower) is divided into Julian Substage (lower) with *Trachyceras desatoyense* (lower) and *Austrotrachyceras obesum* (upper) biozones; Tuvalian Substage (upper) with *Tropites dilleri* (lower), *Tropites welleri* (middle), and *Klamathites macrolobatus* (upper) biozones. Norian Stage (middle) is divided into Early has *Stikinoceras kerri* (lower), *Mayaites dawsoni* (middle), and *Juvavites magnus* (upper biozones; Alaunian Substage (middle) with *Drepanites rutherfordi* (lower) and *Himervites columbianus* (upper) biozones; Late with *Gnomohalorites cordilleranus* (lower), and *Cochloceras amoenum* (upper) biozones. Rhaetian Stage is indicated by the presence of *Choristoceras marshi* biozone.

The Triassic Period in Indonesia

Early Triassic Epoch

Krumbeck (1921) divided the Scythian Epoch of Timor into two horizons, they are: 1. Early

Table 1. The Triassic Chart (Harland *et al*., 1989, part)

Period	Epoch	Stage	Sub-stage	Some biozones	
	TRIASSIC PERIOD				
JURASSIC	**Lias**	Hettangian			208
TRIASSIC	**Late Triassic** (Tr3)	Rhaetian (Rht)	Late (Nor3)	*Choristoceras marshi*	210
		Norian (Nor)	Late (Nor3)	*Cochloceras amoenum*	
				Gnomohalorites cordilleranus	
			Alaunian (Ala)	*Homervites columbianus*	
				Drepanites rutherfordi	
			Early (Nor1)	*Juvavites magnus*	
				Malayites dawsoni	
				Stikinoceras kerri	223
		Carnian (Crn)	Tuvalian (Tuv)	*Klamathites macrolobatus*	
				Tropites welleri	
				Tropites dilleri	
			Julian (Jul)	*Austrotrachyceras obesum*	
				Trachyceras desatoyense	235
	Mid Triassic (Tr2)	Ladinian (Lad)	Late (Lad2)	*Frankites sutherlandi*	
				Maclearnoceras maclearni	
				Maginoceras maginae	
			Early (Lad1)	*Progonociratites poseidon*	
				Eoprotrachyceras subasperum	241
		Anisian (Ans)	Illyrian (Ill)	*Frechites chischa*	
				Frechites deleeni	
			Pelsonian (Pel)	*Anagymnotoceras varium*	
			Aegean (Aeg)	*Lenotropites caurus*	
	Scythian **(Early Triassic)** (Tr1, Scy)	Spathian (Spa)		*Keyserlingites subrobustus*	
				Olenikites pilaticus	
		Nammalian (Nml)	Smithian (Smi)	*Wasatchites tardus*	
				Euflemingites romunderi	
			Dienerian (Die)	*Vavilovites sverdrupi*	
				Proptychites candidus	
		Griesbachian (Gri)	Ellesmerian (Ell)	*Proptychites strigatus*	
				Ophiceras commune	
			Gangetian (Gan)	*Otoceras boreale*	
				Otoceras concavum	245
PERMIAN	**Zec**	Changxing	Dorashamian		

Scythian with *Ophiceras demisso, Meekoceras* sp., *Pseudomonotis subaurita*, *Gervillia subpannonica*, and *Myophoria* sp., and 2. Late Scythian contains *Owenites egrediens* and *Sibirites* sp.

Kummel (1968) made some corrections of the Scythian ammonoid described by Welter (1922) and Wanner (1911) from Timor. According to Kummel, the presence of Scythian in Timor is indicated by the presence of *Owenites simplex*, *O. egrediens*, *Prosphingites austini*, *Vickohlerites sundaicus*, *Metadagnoceras freemani*, *Meekoceras* sp., *Albanites* sp., and *Prohungarites* sp. Table 2 shows the biostratigraphic correlation of the Early and Middle Triassic in Indonesia.

Middle Triassic Epoch

Krumbeck (1921) collected brachiopod *Spirigera stoliczkai* of the Middle Anisian in Timor. The cephalopod facies in this stage belongs to *Sturia mongolica*–facies with *Keyserlingites angustecostatum* (lower), *Sturia mongolica, Japonites ugra* (middle), and *Pseudomonotis intermediaeformis*, and *Monophyllites pseudopradyumna* (upper).

The presence of *Beyrichites* in Misool indicates the presence of Anisian Stage in the upper part of Keskain Formation. *Daonella lilintana* was also found about 5 m below it which here is regarded as Late Anisian age. It is also possible that the Anisian-Ladinian boundary lies between the *Beyrichites* bearing bed and the *Daonella lilintana* bed (Hasibuan, 1991).

In Timor, the cephalopod facies of this stage belongs to *Joannites cymbiformis*-facies with *Monophyllites wengensis*, *Protrachyceras archaelus*, *Daonella indica*, *Tracyceras* cf. *aon*, *Brochidium timorense*, and *Lima subpunctatoides* (Krumbeck, 1921).

The *Daonella* bearing bed is most probably Early Ladinian because there is no stratigraphic gap between it and the *Beyrichites* bed. Other fossils found in this bed are *Terebellina mackayi* and trace fossils regarded as the Anisian-Ladinian age (Hasibuan,

Table 2. Biostratigraphic Correlation for the Early and Middle Triassic of Indonesia

Middle Triassic	**Ladinian**	**Late** (Aon Zone)	*Lima subpunctatoides, Brochidium timorense, Trachyceras cf. aon* (Timor; Krumbeck, 1921)	
		Middle (Lommeli Zone)	*Daonela indica, D. cf. bulogensis, Protrachyceras archelaus, Monophyllites wengensis* (Timor; Krumbeck, 1921)	
		Early (Reitzi Zone)	*Daonella cf. bulogensis, D. cf. indica* (Timor; Krumbeck, 1921)	*Beyrichites, Terbellina mackayi* (Misool Arhipelago: Hasibuan, 1991, 2007; Hasibuan dan Grant-Mackie, 2007b)
	Anisian		*Monophyllites pseudopradyumna* (upper); *Sturia mongolica, Japonites ugra* (middle); *Spirigera stoliczkai, Keyserlingites angustecostatum* (lower) (Timor; Krumbeck, 1921)	*Beyrichites, Daonella lilintana* (Misool Arhipelago: Hasibuan, 1991, 2007; Hasibuan dan Grant-Mackie, 2007b) *Joanites cymbiformis*-facies with *Monophyllites wengensis, Protrachyceras archaelus, Daonella indica, Trachyceras cf. aon, Brochidium timorense, Lima subpunctatoides* (Timor; Krumbeck, 1921)
Early Triassic	**Scythian**	**Late**	*Owenites egrediens, Sibirites sp.* (Timor; Krumbeck, 1921)	*Owenites simplex, O. egrediens, Prosphingites austini, Vickohlerites sundaicus, Metadagnoceras freemanio, Meekoceras sp., Albanites sp., Prohungarites* (Timor; Kummel, 1968)
		Early	*Ophiceras demisso, Meekoceras sp., Pseudomonotis subaurita, Gervillia subpannonica, Myophoria sp.* (Timor; Krumbeck, 1921)	

2007b). Table 2 shows the biostratigraphic chart of the eastern Indonesia in the Early and Middle Triassic.

Late Triassic Epoch

The presence of Early Carnian Stage in Timor is indicated by the existence of *Joanites cymbiformis*, *Waldhausenites* sp., *Miltites* sp., and *Halogyra cipitiensis.* The Late Carnian Stage is indicated by the presence of *Cladicites crassestriatus* and *Tropites subbulatus*. For the whole Carnian Stage other species are also present such as *Koninckina subexpansa, Halobia comata, Pergamidia* sp., *Sagana geometrica, Naticopsis klipsteini Loxonema variscoiformis*, and *Pinacoceras rex* (Krumbeck, 1921).

Arthaber (1927) reported the *Proarcestes ausseeanus, Arcestes antonii, Paracladiscites timidus,* and *Discophyllites floweri* from Oi Batok, Timor indicating the presence of Carnian Stage.

For the Norian Stage, Welter (1914) recorded the Early Norian cephalopoda such as *Halorites ferox, H. superbus timorensis, H. phanois timorensis, H.* cf. *macer, Amarassites sundaicus, Juvavites sandbergeri, J. angulatus, Dimorphites fissicostatus timorensis, D. f. interruptus, Anatomites caroli, A. rothi, Sagenites malayicus, Helictites malayicus, Clionites arestimorensis, C. gandolphi timorensis, A. hughesi, Paratibetites geikiei, P. tornquisti timorensis, P. angustosellatus posterior, Metacarnites dieneri, Distichites pudens, Sirenites evae, S. dianae, Arcestes* cf. *parvogaleatus, Pinnacoceras parma, Placites perauctus, Discophyllites neojurensis, D. debilis timorensis, Proclydonautilus griesbachi, P. gasteroptychus timorensis, Clydonautilus bianglaris, C. noricus timorensis, Gonionautilus salisburgensis timorensis, Pleuronautilus* spp. from Timor. Krumbeck (1921) indicated that the Early Norian in Timor contains *Halorites, Amarassites, Paratibetites insulanus, Neobetites, Pinacoceras parma, Malayites, Halobia verbeeki, H. distincta, H. cf. salinarium, H. cf. superbescens, Indopecten rothpletzi?, Palaeocardita buruca, Lovcenipora*, while the Middle Norian is indicated by the presence of *Trachypleuraspidites malaicus, Halorella nimassica, Misolia aspera, Aulacothyris cf. joharensis, Indopecten subserraticostata, and Halobia cf. lineata*. Late Norian contains *Trachypleuraspidites, Cyrtopleurites, malayicus, Cladiscites tornatus, Montlivaultia norica, M. marmorea,Thecosmillia fenestrata var. multiseptata, T.norica, T. opelli, Monotis salinaria, M. aff. Ochotica Cladiscites tornatus, Cyrtopleurits malayicus*, and *Trachypleuraspidites* sp.

Arthaber (1927) determined *Arcestes subdistinctus, Rhacophyllites neojurensis,* and *Pinnacoceras metternichi* from Oi Batok, Timor.

In Timor, Rhaetian Stage is indicated by the presence of *Choristoceras indoaustralicum* (Krumbeck, 1921). In Misool and Buru Island this stage is indicated by the presence of *Promathildia (P.) pacifica, Neritina* sp., *Coelostylina similis, C.* sp. cf. *C. similis, C. wanner Paleocardita globiformis, P.* cf. *buruca, Protocardia rhaetica, Rhabdoceras suessi, Cochloceras continuecostatum, Indonautilus* aff. *kraffti, Choristoceras* sp., *Cochloceras* sp., and *Serpula* sp. (Jaworski, 1915; Hasibuan, 1991;Hasibuan & Grant-Mackie, 2007). Table 3 shows the biostratigraphic chart of the eastern Indonesian in the Late Triassic.

Discussion

In correlation, ammonites are most reliable, because of their geologically instantaneous migration, wide distribution, and rapid evolution. However, some of the genera or even species of bivalves and other groups are also used, and the combination of bivalves and ammonites can be very useful although such a combination is rather rare in some sequences. Table 4 shows the global biostratigraphic correlation in the Late Triassic.

The brachiopod *Retzia bulaensis* described by Wanner *et al*. (1952) from Triassic sediments of Seram Island slightly differs from *Neoretzia* sp. A of Early Carnian from Misool (Hasibuan, 1991) by having wider ribs. *Retzia reticulate* (Wilckens, 1927) from New Zealand has a similar type of ribbing, but slightly smaller size than Misool specimens. *Neoretzia superbescens* from Europe differs from the *Neoretzia* sp. A by having stronger and fewer ribs, more inflated and slightly more acute of beak (80^{o}) (cf. Misool specimens: 90^{o}). The brachiopod biota *Spiriferina sublilangensis, S. timorensis, S. subgriesbachi,* and *S.* aff. *shalshanensis* from Timor (Krumbeck, 1924) probably belong to genus *Zugmayerella* sp. A from Misool (Hasibuan, 1991) of Early Carnian age. *Z. uncinata* from Luming Formation, Pilot Mountain, Nevada is of Early Norian age (Stanley, 1979). *Spiriferina retziaeformis* from

Table 3. Biostratigraphic Chart of the Eastern Indonesia in Upper Triassic

UPPER TRIASSIC					
CARNIAN		NORIAN			RHAETIAN
Early	Late	Early	Middle	Late	
Joanites cymbiformis, Waldhausenites sp., *Miltites* sp. *Halogyra cipitiensis* (Timor; Krumbeck, 1921)	*Cladicites crassestriatus, Tropites subbulatus* (Timor; Krumbeck, 1921)	*Halorites, Amarassites, Paratibetitesinsulanus, Neobetites, Pinacoceras parma, Malayites, Halobia verbeeki, H. distincta, H.* cf. *salinarium, H.* cf. *superbescens,Indopectenrothpletzi?, Palaeocardita buruca, Lovcenipora vinassai* (Timor; Krumbeck, 1921)	*Trachypleuraspidites malaicus, Halorella nimassica, Misolia aspera, Aulacothyris* cf. *joharensis, indopecten subserraticostata, Halobia* cf. *lineata* (Timor; Krumbeck, 1921)	*Choristoceras indoaustralicum, C.* aff. *ammonotiforme, C.* aff. *marshi, Oxytomainaquivalve* var. *intermedia, Indopectencoronatiformis, Prosogyrotrigonia timorensis* (Timor; Krumbeck, 1921) *Trachypleuraspidites*, *Cyrtopleurites, malayicus, Cladiscites tornatus, Montlivaultia norica, M. marmorea, Thecosmillia fenestrata* var. *multiseptata, T. norica, T. opelli, Monotis salinaria, M.* aff. *ochotica* (Timor; Krumbeck, 1921)	*Choristoceras indoaustralicum* (Timor; Krumbeck, 1921).
Koninckina subexpansa, Halobia comata, Pergamidia sp., *Sagana geometrica, Naticopsis klipsteini, Loxonema variscoiformis, Pinacoceras rex* (Timor; Krumbeck, 1921)		*Arcestes subdistinctus, Rhacophyllites neojurensis, Pinnacoceras metternichi* (Timor; Arthaber, 1927)		*Indopecten misolensis* (Buru, Wanner, 1910a) *Procydonautilus discoidalis*, *P. griesbachi, P. singularis*, *P. (Cosmonautilus) dilleri, P. angustus* and *P. inflatus* (Timor; Welter, 1914)	Promathildia (P.) pacifica, Neritina sp., *Coelostylina similis,* C. sp. cf. C. similis, C. wanner *Paleocardita globiformis, P. cf. buruca, Protocardia rhaetica, Rhabdoceras suessi, Cochloceras continuecostatum, Indonautilus aff. kraffti Choristoceras* sp. , *Cochloceras* sp., Serpula sp., (Buru, Misool Archipelago: Jaworski, 1915, Hasibuan, 1991: Hasibuan & Grant-Mackie, 2007)
Proarcestes ausseeanus, Arcestes antonii, Paracladiscites timidus, Discophyllites loweri Timor; Arthaber, 1927)		*Halorites ferox, H. superbus timorensis, H. phanois timorensis, H.* cf. *macer, Amarassites sundaicus, Juvavites sandbergeri, J. angulatus, Dimorphites fissicostatus timorensis, D. f. interruptus, Anatomites caroli, A. rothi, Sagenites malayicus, Helictites malayicus, Clionites arestimorensis, C. gandolphi timorensis, A.hughesi, Paratibetites geikiei, P. tornquisti timorensis, P. angustosellatus posterior, Metacarnites dieneri, Distichites pudens, Sirenites evae, S. dianae, Arcestes* cf. *parvogaleatus, Pinnacoceras parma, Placites perauctus, Discophyllites neojurensis, D. debilis timorensis, Proclydonautilus griesbachi, P. gasteroptychus timorensis, Clydonautilus bianglaris, C. noricus timorensis, Gonionautilus salisburgensis timorensis, Pleuronautilus* (Timor; Welter (1914)		*Misolia misolica* (Misool Archipelago: Buru, Seram; Hasibuan, 1991)	
Neoretzia sp. A, *Zugmayerella* sp. (Misool Archipelago: Hasibuan,1991)		*Serpula constrictor, Palaeonucula misolensis Modiolus (M.) jaworskii, Pinna (P.)* sp. A, *Pteria sp. A, Costatoria (Vesticostata) vestitaeformis, Myophoria sp., M. subvestita,Palaeocardita globiformis, P. trapezoidalis , Protocardia (Protocardia)* sp. A, *Burmesia* sp. A , B, *Pleuromya* spp (Buru, Misool Archipelago: Wanner, 1910a, b,1931; Krumbeck, 1913, Jaworski, 1915, Hasibuan, 1991)		*Monotis (M.) salinaria, Halobia styriaca, H. suessi, H. comata, H. (H.) austriaca,* (Rote; Hasibuan, 2007a)	

Table 4. Global Correlation Chart for the Middle Triassic of Indonesia

System	Stage	Substage		Indonesia (Misool/ Timor)	Thailand	Europe	Himalaya	China: Mt. Jomlo Lungma	China: South China	New Zealand	Burma	Laos	Vietnam	Kampuchea	Malaysia	Japan	Siberia	North America	
MIDDLE TRIASSIC	LADINIAN	LATE	Longobardian	Bed's with *Protrachyceras archelaus* & *Daonella indica* *Daonella lilintana*	*Daonella indica* Beds	*Protrachyceras archelaus*	*Daonella* Limestone	*Protrachyceras Joanites*	*Protrachyceras deprati, Daonella indica*	*Mentzeliopsis spinosa, Spiriferina kaihikiana, Athyris kaihikuana, Entrochus undatus, "Monotrypella" maorica, Daonella apteryx, Agonisca corbiensis, Patella nelsonensia, Praegonia coobsi*, etc.		Beds with *Protrachyceras*	Beds *with Protrachyceras archaelus*		Beds *with Daonella indica* / Beds with *Daonella pichteri, D. pahangensis*	*Protrachyceras archelaus* / *Daonella subquadrata*	*Nathorstites* Zone	Late	*Frankites sutherlandi*; *Macleamoceras macleami*; *Maginoceras meginae*
		EARLY	Fassan			*Protrachyceras reitzi*	*Daonella Shale*		*Protrachyceras primum*		Beds *with Daonella lommeli*		Beds *with Protrachyceras cf. reitzi*		Beds *with Daonella lommeli*	*Protrachyceras reitzi*	*Neodalmatites* Zone	Early	*Proganociratites Poseidon*; *Protrachyceras subasperum*
	ANISIAN	LATE	Illyrian	*Beyrichites* Zone	*Hollandites, Balatonites* Beds	*Paraceratites trinodosus*	*Ptychites rugifer* (Upper Muschelkalk)	*Ptychites rugifer*	*Paraciratites trinodosua*	*Ptychites cultrate, Leiophyllites marshalli, Parapopanoceras fraseri, P. bartrumi, P. routi, P. tepungai, Monophyllites sphaerophyllus, Mellanium mutchi, M. nodulosum*	Kondeik Limestone with *Paraciratites thuilieri*; Thigaungdaung Limestone with *calcareous algae & foraminifera*	Beds with *Paraceratites trinodosus*	*Paraceratites trinodosus*	Beds with *Paraceratites trinodosus, bivalves & brachiopods*	*Paraciratites trinodosus*		*Frechites* Zone	Late	*Gymnotoceras occidentalis*; *Gymnotoceras meeki*; *Gymnotoceras rothelliformis*
			Pelsonian			*Paraceratites binodosus*			*Paraciratites binodosus*				Beds with *Paraceratites nodosus & Daonella elongate*		*"Myophoria"* sandstone	*Paraceratites cf. trinodosus*; *Hollandites*		Middle	*Balatonites shoshonensis*
		EARLY	Bythynian		*Costatoria* Beds	*Ismidicus* - - - *Osmani*		*Anacrochordiceras nodosus*	*Nicomedites yohi* / Beds with *Costatoria goldfussi mansuyi*										*Acrochordiceras hyatti*
			Aegean		*Hollandites, Leiophyllites* Beds	*Paracrochordiceras Japonites* Beds	Lower Muschelkalk	*Japonites magnus*	*Parapopanoceras nanum*				Beds with *"Monophyllites" suessi, "M". confussii*			*Leiophyllites*	*Beyrichites* Zone	Early	*Lenotropites caurus*

Seram of Late Triassic age reported by Wanner and Knipscheer (1951) probably belongs to genus *Zugmayerella* (Hasibuan, 1991).

Other brachiopods *Misolia misolica* described by Seidlitz (1913) from Misool are very close to Buru (Fogi Beds) (Boehm, 1908). But, *Misolia asymetrica*, *Retzia bulaensis*, and *Paleonucula* sp. from Seram may even be conspecific with Misool fauna. *Misolia noetlingii* (Bittner) and *M. lenticulana* Hudson and Jefferies (1961) from Oman Peninsula, Arabia, are closely related. Both species lie within the range of *M. misolica* and are considered conspecific of Late Norian age.

The Annelida *Terebellina mackayi* found in the Misool Archipelago with ammonoid *Beyrichites* indicates a Ladinian or Anisian age. *Terebellina mackayi* was reported for the first time from the Misool Archipelago by Jaworski (1915), then by Wanner (1931), and lately by Hasibuan (1991, 2007b) from the same area. *Terebellina mackayi* was first described by Bather (1905) from New Zealand and its age ranges possibly from Ladinian to Norian (Campbell and Waren, 1965; Force and Force, 1978; Begg *et al*., 1983). The species probably also occur in Thailand within Carnian strata and Ladinian strata with *Daonella* in Malaysia (Grant-Mackie pers. comm.). *Serpula* sp. recorded from the Fogi Beds, West Buru by Krumbeck (1913). Hasibuan (1991) regarded the species is conspecific with the Misool specimens as *Serpula constrictor* of Jaworski (1915) with *Rhabdoceras* and *Cochloceras* indicating a Norian age.

Hasibuan (1991) recorded *Promathildia (Promathildia) pacifica* Jaworski from the Lios Member of Bogal Formation of Rhaetian age. Hasibuan and Grant-Mackie (2007) reviewed Triassic and Jurassic gastropods collection from the same formation *Neritina* sp. indet and judged to be Rhaetian because their position above the *Rhabdoceras/Cochloceras*-bearing Lios Member and below the unconformity at the base of Jurassic sequence. From the same locality, they also described gastropod *Coelostylina* sp. cf. and *C. similis* Münster. Jaworski (1915) recorded three species e.g. *Coelostylina: C. wanner, C. similis,* and *Coelostylina* sp.

Palaeonucula misolensis, a bivalve from Lios Member, Bogal Formation in the Misool Archipelago has a Norian age and also recorded from Fogi Beds in Buru (Jaworski, 1915). Hudson and Jefferies (1961) recorded probably the same species from Oman Peninsula, Arabia, and also from Yunnan of Late Triassic beds. *Modiolus (Modiolus) jaworskii* was also recorded with *Palaeonucula misolensis*, *Pinna (Pinna)* sp. A, *and Pteria* sp. A from the same formation (Hasibuan, 1991) and the species was also recorded from Oman Peninsula, Arabia by Hudson and Jefferies (1961). *M. (M.) jawroskii* is very similar to *M*. cf. *rablianus* and *M. raubensis* from Late Triassic of Pahang, Malaysia and with also *Modiolus* sp. from Late Triassic of Chile reported by Hayami *et al*. (1977).

Bivalve *Indopecten misolensis* from Misool similar to ammonite *Ceratitites* fauna from Bilkofan, Buru (Wanner 1910a). *Indopecten* in Thailand has an Early to Middle Norian (Chonglakmani, 1981) and Early Norian in Himalaya (Bhalla, 1983), but in Misool has a Late Norian in age. Fauna with *Indopecten* in Oman, Arabia has a Norian age (Hudson and Jefferies, 1961). The fauna from Iran, Spiti and the Sumra and Asfal Formations have a similar fauna with Misool (Bogal Formation) and at least in the Norian (Douglas, 1929). The O Combor beds in Kampuchea yields *Palaeocardita* cf. *buruca* (Saurin, 1956) which can be correlated with Misool and closely with Fogi Beds in Buru of Norian age. The European Zlambach Marl yielded *Paleocardita globiformis, Protocardia rhaetica, Coelostylina similis, Rhabdoceras suessi, Cochloceras continuecostatum,* and others which are comparable with Misool fauna in Rhaetian age (Jaworski, 1915). *Rhabdoceras suessi* is also present in North America. The presence of *Monotis* in Seram, Buton, and Rote Islands and other parts of Indonesia is not known in Misool (Hasibuan, 2007a). *Monotis* is widely distributed in the world such as in New Zealand, New Caledonia, Japan, British Columbia, Soviet Far East, and Western Canada of Norian age (Grant-Mackie, 1978, 1980, 1985). *Monotis* is an indicator for Norian Stage, because no *Monotis* were found other than this age (Grant-Mackie, 1978).

Costatoria is a group of bivalve Myophoridae with many species in South East Asia. *C. subvestita, C. vestita, C. vestitaeformis,* and *C. moluccana* are included in the *vestita* group of subgenus *Vesticostata* Kobayashi and Tamura (1968). The specimen found in Misool Archipelago is regarded as Myophoridae *Costatoria (Vesticostata) vestitaeformis* of Norian age, and very close to the *Costatoria quin-*

quecostata from Chegar, Perak, Malaysia. *C. (C.) chenopus, C. (C.) goldfussi, C. (C.) inaquecostata, C. (C.) kokeni, C. (C.) vestita,* and *C. (C.) whateleyae* from Italy (Allasinaz, 1966) in general differ from *C. (V.) vestitaeformis* from Misool. *Costatori malayensis* that has a Ladinian age, *C. chegarperakensis* of an Anisian age in Malaysia, and *C. (Costatoria) subrotunda* that is probably close to Anisian *C. chegarperakensis* in Europe (Loriga and Posenato, 1986) is a Smithian marker. *Myophoria* sp. was reported by Wanner (1910a,b) from Late Triassic of Lios Member, in Misool Island and also by Wanner in 1931. *Myophoria. subvestita* from Wamkaha, Gugu Tama, Bilkofan, West Buru, was described by Krumbeck (1913).

Carditidae *Palaeocardita globiformis* and *P. trapezoidalis* and Cardiidae *Protocardia (Protocardia)* sp. A, *Burmesia* sp. A and B, *Pleuromya* spp. were also collected from Lios Member, Bogal Formation in Misool. *Cardita globiformis* was also recorded by Jaworski (1915) from the same formation. Musper (1929) regarded that the *Palaeocardita globiformis* is also present in Padang Highlands, Sumatra. The species is also widely distributed in Norian of Viet Nam (Vu-Khuc *et al*. (1965). *Palaeocardita trapezoidalis* from Fogi Beds, Buru is Norian, also in Oman (Hudson and Jefeferies, 1961), in Early Norian in Hong Hoi Formation, Thailand (Chonglakmani, 1981), but Carnian in Peru (Kőrner, 1937). It has also been reported from Late Triassic of Yunnan (Ma, 1977), New Zealand (Trechmann, 1918; Marwick, 1953), and Mexico (Kristan-Tolmann, 1986). *Protocardia (Protocardia)* sp. is very close to *P.* cf. *contusa* from Bilkofan, Buru. The species differs from *P. rhaetica* of Jaworski (1915), but also close to *P*. aff. *contusa* of Krumbeck (1913) and to *P. subrhaetica* (Krumbeck (1923) from the Late Triassic of Seram Island. *Burmesia praecursor* and *B.* aff. *lirata* are present in Fogi Beds, west Buru (Krumbeck, 1913), while Jaworski (1915) regarded that *Pholadomya mirabilis* from Buru and Sumatra is a member of genus *Burmesia*. *Neoburmesia* present in Japan (Yabe and Sato, 1942), *Burmesia lirata,* and *Unionites griebachi* etc. constitute the *B. lirata* assemblage (Chen, 1990). This Early Norian assemblage is equivalent to the fauna of the Napeng Beds from Burma and similar to Katialo Beds of Sumatra, the Fogi Beds of Buru, and the Asfal or Sumra Limestone of Oman. *Burmesia* Healey was originally a Napeng genus, but it is known from Norian to Liassic and from Jordan to Japan through Burma and Indonesia (Kobayashi and Tamura, 1983). *Pleuromya sulcatissima* and *P. deningeri* are present in Wamkaha, Fogi Beds, West Buru (Krumbeck, 1913), and *Pleuromya* sp. from Misool (Hasibuan, 1991).

The presence of *Daonella indica* with *D.* cf. *bulogensis*, and *D. pichleri* var. *timorensis* in the Ladinian is probably correlatable with the upper part of the Keskain Formation in Misool. *Daonella indica* from Himalaya of Ladinian age (Reed, 1927; Chen,1974; Yi-kang and Guo-xiong, 1976) and *D. apteryx* from New Zealand are probably correlative with the upper part of Keskain Formation containing *Daonella (D.) lilintana*. *Daonella indica, D. pichleri,* and *D. pahangensis* have a Late Ladinian age in Malaysia (Kummel, 1960; Sato, 1964). *Terebellina mackayi* from Misool, New Zealand, Thailand, and Sumatra are probably of Anisian to Ladinian age (Hasibuan, 1991). The presence of ammonite *Beyrichites* in Misool which is also present in Thailand (Chonglakmani, 1981) indicates an Anisian age. Kittl (1912) placed *Daonella (D.) lilintana* in the *D. tyrolensis* Group with *D. bulogensis, D. tyrolensis, D. arzelensis, D. indica, D. léczyi, D. spitiensis, D. tripartite, D. taramelli, D. frami, D. parthanemsis, D. imperialis, D. (?) amperta, D. cassiana,* and *D. latecostata* and he believed it is also found in Sumatra. This study accepts that *D. lilintana* belongs to the subgenus *Daonella* in the *D. tyrolensis* Group. Table 5 shows the global biostratigraphic correlation in the Late Triassic. Figure 1 show the selected species resulted from recent study (Hasibuan, 1991).

Nautiloid *Procydonautilus discoidalis, P. griesbachi, P. singularis, P. (Cosmonautilus) dilleri, P. angustus,* and *P. inflatus* recorded from Timor (Welter, 1914) are of Late Norian age. The specimen from Misool (*Proclydonautilus* sp.) is difficult to compare with those mentioned and differs also from *P. mandevillei* from Otamitan of New Zealand. *Indonautilus* cf. *kraffti* was first reported from Misool by Jaworski (1915). Hasibuan (1991) regarded that *Indonautilus* aff. *kraffti* from the Bogal Formation, Misool (Rhaetian) is similar to *I. awadi* and *Proclydonautilus* from Sinai and Israel (Kummel, 1960).

The ammonoid *Beyrichites* is first recorded from the Keskain Formation, Misool Archipelago by Hasibuan (1991). *Beyrichites (B.) yuati* of Skwarko

Table 5. Global Correlation Chart for the Upper Triassic of Indonesia

System		UPPER TRIASSIC						
Stage		NORIAN				KARNIAN		
Substage		Rhaetian	Sevatian	Alaunian	Lactinian	Tuvalian	Julian	"Cordevol"
		Late		Middle	Early	Late	Middle	Early
INDONESIA	MISOOL	*Misolia misolica*	*Rhabdocerassuessi, Cochlocerascontinuecostatum, Costatoria(Subvestita)vestitaeformis,Burmesia, Palaeocarditaglobiformis,P. trapezoidalis,Indopecten*					*Zugmayerella, Neoretzia,Trocholina*
INDONESIA	TIMOR & ROTE – Ammonoids	*Choristoceras, Trachypleuraspidites*				*Tropites subbulatus*		*Joanites cymbiformis, Trachyceras* cf. *aon*
INDONESIA	TIMOR & ROTE – Bivalves		*Monotis Beds*	*Indopecten seinamensis*	*Halobia distincta*	*Halobia austriaca-tropitum*	*Halobia charlyana*	*Halobia styriaca*
INDONESIA	SERAM	*Monotis (Pacimonotis) subcircularis*						
INDONESIA	BURU	Fogi Formation with *Misolia*						
INDONESIA	BUTON	*Cassianella, Hoernesia, Misolia*		*Monotis (Pacimonotis) subcircularis*				
THAILAND		"Kamawkala Fauna" of Northwest and West Thailand		? *Indopecten* Zone		*Halobia distincta* Zone	*Halobia parallela* Zone	*Halobia charlyana* Zone; *Trigonodus* Zone; *Paratrachyceras* Zone
EUROPE		*Choristoceras marshi*	*Rhabdoceras suessi*	"*Halorites* Horizon"; *Cyrtopleurites bicrenatus*	*Juvavites magnus, Mayaites paulckei, Mojsisovites kerri*	*Anatropites spinosus, Tropites bullatus, T. dilleri*	"*Sirenites* Horizon" *Trachyceras austricum, T. aonoides*	*T. aon*
HIMALAYA	SPITI	*Megalodon* Bed (Kioto Lst.)	Quartz series	*Monotis* Shale; Coral Limestone	*Juvavites* Beds	Dolomitic Limestone *Tropites* Shale	Grey Beds	*Halobia* Limestone
HIMALAYA	PAINKHANDA			*Halorites* Bed	Nodular Limestone (*Hauerites* Bed)	Shale and Limestone with *Halobia comata*		*Traumatocrinus* Limestone
CHINA	MT. JOLMO LUNGMA		*Pinacoceras metternichi*	*Cyrtopleurites socius*	*Indojuvavites angulatus, Griesbachites-Goniotites, Nodotibetites dieneri*	*Parahauerites acutus, Hoptotropites, Indonesites dieneri*		*Protrachyceras-oannites*
CHINA	SOUTH CHINA			*Burmesia lirata-Costatoria napengensis* with *Halobia* cf. *fallax, H. newmayi long*	*H. ganziensis, H. fallax parva*	*Halobia pluriradiata, H. superba*	*H. talauana, H. substyriaca*	*H. comata, H. comatoides*
BURMA			Napeng Beds ?	Kamawkala Limestone ?				
NORTH VIETNAM & NORTH LAOS		Limestone of Ban-O Beds with *Gervilleia praecursor & Rhaetoavicula contorta*	Beds with *Halobia lineata*		Red Limestone of Pa-Ma with brachiopods	Beds with *Halobia pluriradiata*	Beds with *Halobia superba*; *Beds with Halobia comata*	*Beds with Halobia rugosa*
SOUTH VIETNAM & KAMPUCHEA		Beds of the O Kombor with *Palaeocardita* cf. *buruca* & beds with *Gervilleia praecursor* & *Rhaetoavicula contorta*	*Didymites* & bivalves beds			Beds with *Discotropites* & *Hauerites*	*Beds with Pachycardia rugosa*; *Beds with Thisbites & Daonella cf. multilineata*	Beds with Posidonia cf. wengensis, Halobia & Daonella
MALAYSIA & SINGAPORE		*Himavites*	*Amarrasites*	*Guembelites*	Jurong Fauna	*Halobia parallela*	*Halobia talauana*; *Halobia cf. styriaca, Daonella cf. multilineata* Mt. Faber Fauna	*Beds with Paratrachyceras*
JAPAN			*Monotis* Beds (*Placites* & *Arcestes* Beds)		Aso Formation *Halobia aotii-obsoleta*	Iwai Formation *Halobia austriaca*	*Halobia-Pecten Beds with H. kawadai, moluccana, Oxytoma-Mytilus Beds with H. kashiwaiensis*; *Paratrachyceras* cf. *hofmanni*	*Atsu Formation H. atsuensis, Daonella yoshimurai*
		Late		Middle	Early	Late	Early	
NORTH AMERICA		*Choristoceras marshi*	*Rhabdoceras suessi*	*Himavites columbianus, Drepanites rutherfordi*; *Juvavites magnus*	*Malayites dawsoni, Mojsisovites kerri*	*Klamathites macrolobatus, Tropites welleri, T. dilleri*	*Sirenites nanseni*	*Thyracceras obesum*
NEW ZEALAND (Key fossils only)		*Rastelligera diomedea, Clavigera,Psioidiella, Psiodea, Otapiria, Manticula problematica, Oretia coxi, Monotis (Entomonotis), M . (Eomonotis), Proclydonautilus, Pinacoceras, Cladiscites, Rhacophyllites, Arcestes, Heterastridium, Prograhularia*						

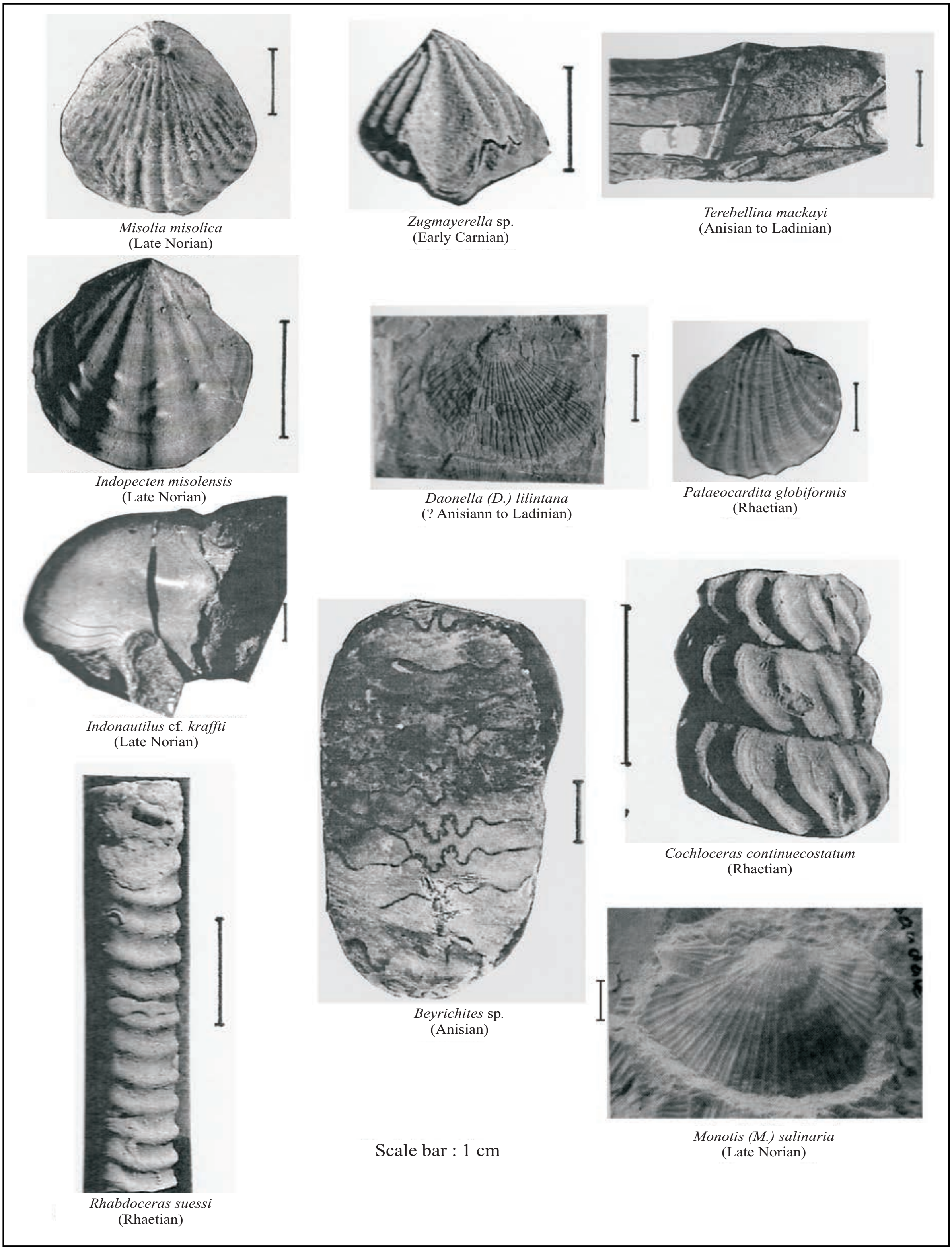

Figure 1. Photographs of selected species from the Keskain and Bogal Formations, Misool Archipelago; and Aitutu Formation, Rote Island.

(1973) from New Guinea has Late Scythian to Anisian age. *B. falciforme* of Middle Triassic of North America were described by Smith (1914). *Beyrichites (B.) kesava* was also recorded from Himalaya. *Beyrichites* of Hirsch (1977) was reported from Vietnam within Anisian strata by Vu-Khuc *et al*. (1965). Hirsch (1977) also reported *B. cognatus* from Late Anisian strata of Catalogne (Spain). Chonglakmani (1981) mentioned the presence of *B. (B.) srikanta* from Changwat Lampang, Thailand, which is also Anisian. *Rhabdoceras suessi* was first recorded from Lios Member, Bogal Formation in Misool by Wanner (1910a, 1931) and later followed by Jaworski (1915) and Rutten (1927) from the same location. Hasibuan (1991) redescribed the species from the same horizon. Hyatt (1892) and Cox (1949) regarded *Rhabdoceras* as an age indicator for the Norian (see also Thenius, 1980). Siberling and Tozer (1968) regarded the age of *R. suessi* in North America as Late Norian, or Rhaetian in this work. Wiedmann *et al*. (1979) claimed that *R. suessi* ranges from Early Late Norian to Late Norian (Early Rhaetian to Late Rhaetian). *Cochloceras* sp. was reported by Wanner (1910a,b) from the Lios Member, Bogal Formation, Misool. Later Jaworski (1915), Wanner (1931), and Hasibuan (1991) regarded the specimens belong to *Cochloceras continuecostatum* from the same bed. Rutten (1927) reported another species *C. canalicatum* from the same horizon. *Cochloceras* is well-known from the Alps (*e.g. C. fischeri*) and from other parts of Indonesia (*e.g*. Timor Island). The age of *Cochloceras* is regarded as the uppermost Triassic that it characterizes the middle part of the Norian (Tozer, 1979) *e.g.* in North America and the Tethys. In Misool it was found with *Rhabdoceras suessi*.

Conclusions

It can be concluded that the Triassic of Indonesia can be subdivided into several stages based on the marine biota as follows:

Early Scythian Stage (The Early Triassic Epoch) is indicated by the presence of *Ophiceras demisso*, *Meekoceras* sp., *Pseudomonotis subaurita*, *Gervillia subpannonica*, and *Myophoria* sp., whilst Late Scythian is indicated by the presence of *Owenites egrediens* and *Sibirites* sp. (Krumbeck, 1921).

Anisian Stage (The Middle Triassic Epoch) is indicated by the existence of species *Sturia mongolica*–facies with *Keyserlingites angustecostatum* (lower), *Sturia mongolica, and Japonites ugra* (middle); and *Pseudomonotis intermediaeformis, and Monophyllites pseudopradyumna* (upper); and also *Joannites cymbiformis*-facies with *Monophyllites wengensis, Protrachyceras archaelus, Daonella indica, Tracyceras* cf. *aon*, *Brochidium timorense*, and *Lima subpunctatoides* (Krumbeck, 1921).

Lower Ladinian Stage is known based on the presence of *Beyrichites* sp. and *Daonella lilintana* (Hasibuan, 1991), and *Terebellina mackayi* (Hasibuan, 2007b; Hasibuan and Grant-Mackie, 2007). The Middle Ladinian Stage is based on the presence of *Daonella indica*, *D*. cf. *bulogensis*, *Monophyllites wengensis, Protrachyceras archaelus* (Krumbeck, 1921), and *Lima subpunctatoides, Tracyceras* cf. *aon, Brochidium timorense* (Upper Ladinian) (Krumbeck, 1921).

Carnian Stage (The Late Triassic Epoch) (Early Carnian) contains *Joanites cymbiformis, Waldhausenites* sp., *Miltites* sp., *Halogyra cipitiensis* (Krumbeck, 1921) and *Neoretzia* sp., and *Zugmayerella* sp. (Hasibuan, 1991). In Late Carnian *Cladicites cressestrianus*, *Tropites subbulatus* are reognized (Krumbeck, 1921).

Lower Norian Stage is shown by the presence of *Halorites ferox, H. superbus timorensis, H. phanois timorensis, H.* cf. *macer, Amarassites sundaicus, Juvavites sandbergeri, J. angulatus, Dimorphites fissicostatus timorensis, D. f. interruptus, Anatomites caroli, A. rothi, Sagenites malayicus, Helictites malayicus, Clionites arestimorensis, C. gandolphitimorensis, A. hughesi, Paratibetites geikiei, P. tornquisti timorensis, P. angustosellatus posterior, Metacarnites dieneri, Distichites pudens, Sirenites evae, S. dianae, Arcestes* cf. *parvogaleatus, Pinnacoceras parma, Placitesperauctus, Discophyllites neojurensis, D. debilis timorensis, Proclydonautilusgriesbachi, P. gasteroptychus timorensis, Clydonautilus bianglaris, C. noricustimorensis, Gonionautilus salisburgensis timorensis*, and *Pleuronautilus* spp. fromTimor (Welter, 1914). *Arcestes subdistinctus, Rhacophyllites neojurensis*, and *Pinnacoceras metternichi* from Timor, (Arthaber,1927); *Halorites, Amarassites, Paratibetites insulanus, Neobetites, Pinacoceras parma, Malayites, Halobia verbeeki, H. distincta, H.* cf. *salinarium, H.* cf. *superbescens,* *Indopecten rothpletzi, Palaeocardita buruca, and Lovcenipora vinassai* from Timor (Krumbeck, 1921). *Serpula constrictor, Palaeonucula misolensis, Modiolus (M.) jaworskii, Pinna (P.)* sp. A, *Pteria* sp. A, *Costatoria (Vesticostata) vestitaeformis, Myophoria* sp., *M. subvestita, Palaeocardita globiformis* and *P. trapezoidalis, Protocardia (Protocardia)* sp. A, *Burmesia* sp. A, B, and *Pleuromya* spp. (Buru, Misool Archipelago, Wanner, 1910a,b, 1931; Krumbeck,1931, Jaworski,1915, Hasibuan,1991) are also the indications of Lower Norian Stage.

Middle Norian Stage is defined by the presence of *Trachyoleuraspidites malaicus, Halorella nimassica, Misolia aspera, Aulacothyris* cf. *joharensis, Indopecten subserraticostata,* and *Halobia* cf. *lineata* from Timor (Krumbeck, 1921).

Late Norian indicated by the existense of *Choristoceras indoaustralicum, C.* aff. *ammonitiforme, C.* aff. *marshi, Oxytoma inaquivalve* var. *intermedia, Indopecten coronatiformis, Prosogyrotrigonia timorensis Trachypleuraspidites, Cyrtopleurites malayicus, Cladiscites formatus, Montlivaultia norica, M. mamorea, Thecosmillia fenestrate* var. *multiseptata, T. norica, T. opelli, Monotis salinaria, and M.* aff. *ochotica* from Timor (Krumbeck, 1921); *Indopecten misolensis* from Buru (Wanner, 1910a); *Proclydonautilus discoidalis, P. griesbachi, P. singularis, P. (Cosmonautilus) dilleri, P. angustus,* and *P. inflatus* from Timor (Welter, 1914); *Misolia misolica* from Misool, Buru, Seram (Hasibuan, 1991); *Monotis (M.) salinaria, Halobia styriaca, H. suessi, H. comata,* and *H. (H.) austriaca* from Rote (Hasibuan, 2007a).

Rhaetian Stage indicators are *Choristoceras indoautralicum* from Timor (Krumbeck, 1921); *Promathildia (P.) pacifica, Neritina* sp., *Coelostylina similis, C.* sp. cf. *C. similis, C. wanner, Paleocardita globiformis, P.* cf. *buruca, Protocardia rhaetica, Rhabdoceras suessi, Cochloceras continuecostatum, Indonautilus* aff. *kraffti, Choristoceras* sp., *Cochloceras* sp., and *Serpula* sp. from Buru, Misool (Jaworski, 1915; Hasibuan, 1991; Hasibuan & Grant-Mackie, 2007).

The Triassic fauna of Indonesia is quite diverse and it is distributed on small islands, because the Indonesian Archipelago comprises different tectonic fragments (terranes) which have been brought together by subduction and collisions and it can be useful in both local and interregional correlation. The faunas are well-fitted with global correlation at least in the Triassic time. Any biostratigraphic study in Indonesia in the future can be tied to the biostratigraphy of Misool Archipelago especially in Mesozoic, because the archipelago has been studied in more detailed and has a very reliable successions.

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References

Allasinaz, A., 1966. Il Trias in Lambordia XVIII. La fauna a lamellibranchi dello Julico (Carnico medio). *Rivista Italiana di Paleontologia e Stratigrafia,* 72(3), p. 609-752. Milano.

Arthaber, G. Von, 1927. Ammonoidea Leiostraca aus der Oberen Trias von Timor. *Jaarboek van het Mijnwezen in Nederlandsch-Indie, 55E Jaargang, 1926, Verhandelingen*, 2, p.1-174, 20 Tafel, 19 Textfigures.

Bather, F.A., 1905. The Mount Torlesse annelid. *Geological Mag*azine (London), p.532-542.

Bather, G. Von, 1929. Triassic Echinoderms of Timor. *Paläontologie von Timor,* 16, p.214-272, 2 Plates.

Begg, J.G., Cave, M.P., and Campbell, H.J., 1983. *Terebellina mackayi* Bather in Oretian rocks, Wairaki Hills, Southland (Note). *New Zealand Journal of Geology and Geophys*ics, 26, p.121-122.

Bhalla, S., 1983. The Mesozoic. *In*: Moullade A.M. and Nairn, A.E.M. (eds), *The Phanerozoic Geology of the World II, B,* p.305-351, 8 abh. 9 Tab. Amsterdam (Elsevier).

Boehm, G., 1904. Geologische Ergebnisse einer Reise in den Molukken. *Comptes Rend*us, 9th *Conggres International, Vienna* 1903, p.657-662.

Boehm, G., 1905. Ueber Brachiopoden aus Einem Aelteren Kalkstein der Insel Ambon. *Jaarboek van het Mijnwezen, Oost-Indie Wetenschappelijke Mededeelingen, Gedeelte* 34, p.88-93.

Boehm, G., 1908. Beschreibung eines Ammoniten von Südwest Neu Guinea. *Koninklijke Nederlandsch Aardrijkskunde Genootschaap, Leiden*, 409-410.

Bülow, E. Von, 1915. Orthoceren und Belemnitiden der Trias von Timor. *Paläontologie von Timor,* 4(7), p.1-72, 6 Tafel, 24 Textfigures.

Campbell. J.D. and Warren, G., 1965. Fossil localities of the Torlesse Group in the South Island. *Transactions and Proceedings of the Royal Society, New Zealand,* 3(8), p.99-137.

Chen, Chu-chen, 1974. *A Handbook of the Stratigraphy and Paleontology in S.W. China*. Edited Nanking Institute of

Geology and Paleontology (Ed.), Academic Sin Science Press.

Chen, Chu-chen, 1990. Marine Triassic lamellibranch assemblage from southwest China. *Rivista Italiana di Paleontologia e Stratigrafia,* 85(3-4), p.1189-1196.

Chonglakmani, C., 1981. *The systematics and biostratigraphy of Triassic bivalves and ammonites of Thailand*. Unpubl. Ph. D. Thesis. Auckland University, New Zealand.

Cox, L.R., 1949. Upper Triassic mollusca from Peru. *Instituto Geologia del Peru*, *Bulletin*, 12, 44 pp.

Diener, C., 1923. Ammonoidea trachyuostraca aus der Mittleren und Oberen Trias von Timor., *Jaarboek van het Mijnwezen, Nederlandsch Oost-Ind*ie, 5,p.75-276, 32 tafel.

Douglas, J.A., 1929. A marine Triassic fauna from Eastern Persia. *Quarterly Journal of the Geological Society of London,* 85, p.624-650.

Force, L.M. and Force, E.R., 1978. Triassic rocks of the Black Forest-Haldon area, MacKenzie Country, South Island, New Zealand. *New Zealand Journal of Geology and Geophys*ics, 21, p.747-760.

Frech, F., 1905. Untere Trias in Timor und Obertrias der Molukken. Nachtrag zur Trias Asiens. In: Frech, F. (Ed.), *Lethaea geognotica. 2. Das Mesozoicum*, p.541-542.

Gerth, H., 1915. Die Heterastridien von Timor. *Paläontologie von Timor*, 2, p.63-69, 1 Tafel.

Gerth, H., 1927. *Ein Heterastridium* Mit Eigenartiger Oberflachen Skulptur aus dem Perm von Timor. *Leidsche Geologische Mededeelingen*, 2, p.223-225, 1 Tafel.

Grant-Mackie, J.A., 1978. Status and identity of the New Zealand Upper Triassic bivalve *Monotis salinaria* var. *richmondiana* Zittel 1864. *New Zealand Journal of Geology and Geophys*ics, 21(3), p.375-402.

Grant-Mackie, J.A., 1980. Systematics of New Zealand *Monotis* (Upper Triassic Bivalvia): subgenus *Inflatomonotis*. *New Zealand Journal of Geology and Geophys*ics, 23, p.629-637.

Grant-Mackie, J.A., 1985. The Warepan Stage of the Upper Triassic: redefinition and subdivision. *New Zealand Journal of Geology and Geophys*ics, 28, p.701-724.

Harland, W.B., Armstrong, R.L., Cox, A.V., Craig, L.E., Smith A.G., and Smith D.G., 1989. *A geologic time scale*. Cambridge University Press.

Hasibuan, F., 1991. *Mesozoic and Paleontology of Misool Archipelago, Indonesia*. Ph. D. Thesis, University of Auckland, New Zealand.

Hasibuan, F., 2007a. Penelitian Biostratigrafi Mesozoikum Pulau Rote, Nusa Tenggara Timur. *Jurnal Sumber Daya Geologi,* XVII(3), p.126-144.

Hasibuan, F., 2007b. Annelid *Terebellina mackayi* (Bather) from Middle Triassic Keskain Formation, Misool Archipelago. *Journal of Geological Resources*, XVII(2), p.116-123.

Hasibuan, F. and Grant-Mackie, J.A. 2007. Triassic and Jurassic Gastropods from the Misool Archipelago, Eastern Indonesia. *Jurnal Sumber Daya Geologi,* XVII (4), p.257-272.

Hayami, I., Maeda, S. and Fuller, C.R., 1977. Some Late Triassic Bivalvia and Gastropoda from Domeyko Range of North Chile. *Transactions and Proceedings of the Palaeontological Society of Japan*, New Series, 108 , p.202-221.

Hirsch, P. F., 1977. Essai de correlation biostratigraphique des niveaux mesoet Neotriasiques de facies <<Muschelkalk>> du domaine sepharade. *Cuadevuos Geologia Iberiea*, 4, p.511-526, Madrid.

Hudson, R.G.S. and Jefferies, R.P.S., 1961. Upper Triassic Brachiopods and Lamellibranchs from the Oman Peninsula, Arabia. *Paleontology,* 4(1), p.1-41.

Hyatt, A., 1892. Remarks on the Pinnidae. *Proceedings of the Boston Society of Natural History*, 25, p.335-346.

Ishibashi, J., 1975. Some Triassic Ammonites from Indonesia and Malaysia. *Geology and Paläontology of Southeast Asia*, 16, p.45-56, 1 Plate, 3 Text Figures.

Jaworski, E., 1915. Die Fauna der Obertriadischen Nuculamergel von Misol. *Paläontologie von Timor*, 2(5), p.73-174, 3 Tafel.

Jaworski, E., 1927. Obertriadische Brachiopoden von Ambon (Molukken). *Jaarboek van het Mijnwezen in Nederlandsch Oost-Ind*ie, 1926(3), p.201-229, 1 Tafel.

Kieslinger, A., 1924. Die Nautiloideen der Mittleren und Oberen Trias von Timor *Jaarboek van het Mijnwezen in Nederlandsch Oost-Ind*ie, 41E, p.51-145, 7 Tafel, 35 Textfigures.

Kittl, E., 1912. *Materialien zu Einer monographie der Halobiidae und Monotidae der Trias*. Druck Der K.U.K. Hofbuchdruckerei Victor Hornyanszky, Budapest.

Kobayashi, T. and Tamura, M., 1968. *Myophoria* (S.L) in Malaya with a Note on the Triassic Trigoniacea. *Geology and Palaeontology of Southeast Asia,* 5, p.88-137, 3 Plates.

Kobayashi, T. and Tamura, M., 1983. On the Oriental Province of the Tethyan Realm in the Triassic Period. *Proceedings of the Japan Academy*, 59(7), ser. B, p.203-206.

Kőrner, K., 1937. Marine (Cassianer-Raibler) Trias am Nevado de Acratambo (Nord. Peru). *Palaeontography,* A 86, p.145-240.

Kristan-Tollmann, E., 1986. Triassic of the Tethys and its relation with the Triassic of the Pacific Realm. *International Symposium on Shallow Tethys* 2. Wagga Wagga.

Krumbeck, L., 1913. Obere Trias von Buru und Misol. *Palaeontography Supplements*, 4(2), p.1-61.

Krumbeck, L., 1921. Die Brachiopoden, Lamellibrachiaten und Gastropoden der Trias von Timor. 1. Stratigraphischer Teil. *Paläontologie von Timor*, 10(11), p.1-142.

Krumbeck, L., 1923. Zur Kenntnis des Juras der Insel Timor, Soewi des Aucellen Horizontes von Seram und Buru. *Paläontologie von Timor,* 12, p.1-120.

Krumbeck, L., 1924. Die Brachiopoden. Lamellibranchiaten und Gastropoden der Trias von Timor II. Paläontogischer Teil. *Paläontologie von Timor*, 13, p.143-417, 20 Tafel, 4 Textfigures.

Kummel, B., 1968. Scythian Ammonoids from Timor. *Breviora Museum of Comparative Zoology*, 283, p.1-21.

Kummel, B., 1960. New Zealand Triassic ammonoid. *New Zealand Journal of Geology and Geophy,* 3(3), p.486-509.

Loriga, C.B. and Posenato, R., 1986. Costatoria (Costatoria?) subrotunda (Bittner, 1901) a Smithian (Lower Triassic) marker from Tethys. *Rivista Italiana di Paleontologia e Stratigrafia*, 92(2), p.89-200.

Ma, Qi-H., 1977. Mesozoic Fossil Lamellibranch from Yunnan. In: *Mesozoic Fossil from Yunan, China,* 1, p.161-386. Beijing Science Publishing House.

Marwick, J., 1953. Division and Faunas of the Hokonui System (Triassic and Jurassic). *Paleontological Buletin, New Zealand Geological Surv*ey, 21.

Musper, K.A.F.R., 1929. Beknopt verslag over de uitkomsten van nieuwe geologische onderzoekingen in de Padangsche Bovenlanden. *Jaarboek van het Mijnwezen in Nederlandsch Oost-Indie,* 58, p.265-331.

Reed, F.R.C., 1927. Paleozoic and Mesozoic Fossils from Yunnan. *Paleontologia Indica. New Series,* 10(1), p.1-291.

Renz, C., 1905. Die Austral - Asiatische Provinz. 3. Molukken. *Lethaea Geognotisca,* In: French, F. (Ed.), *Das Mesozoicum*, p.212-213.

Rosidi, H.M.D., Tjokrosapoetro, S., and Gafoer, S., 1996. *Peta Geologi Bersistem, Timor, Lembar Kupang:* 2205-2305-2306, skala 1: 250.000. Pusat Penelitian dan Pengembangan Geologi, Bandung.

Rothpletz, A., 1892. Die Perm-, Trias-, und Jura-Formation auf Timor und Rotti im Indischen Archipel. *Paläontografie,* 39, p.57-106. 6 Tafel.

Rutten, L.M.R., 1927. De noordlijke molukken en de Radja-Ampat-Group. In: *Voordrachten over de Geologie van Nederlandsch Oost-Indië,* p.761-781.

Sato, T., 1964. Études biostratigraphiques des ammonites du Jurassiques du Japon. *Society Géology France Mem*oir, 94, p.1-122.

Saurin, E., 1956. *Lexique stratigraphical international*. 3(fsc. 6a) Indochina, Paris.

Seidlitz, W. Von, 1913. *Misolia,* Eine Neue Brachiopodengattung aus den Arthyridenkalken von Buru und Misool. *Paläontographica Supplements*, 4(2)1, p.163-193, 3 Tafel, 9 Textfigures.

Siberling, N. and Tozer, E., 1968. Biostratyigraphic Classification of the Marine Triassic in North America. *Special Paper, Geological Society of Am*erica, 110, p.1-63.

Skwarko, S.K., 1973. On the discovery of Halobiidae (Bivalve Triassic0 in New Guinea. *B.M.R. Geology and Geophysics, Bull*etin, 126, p.51-54, Paleontology Paper.

Smith, J.P., 1914. Middle Triassic marine invertebrate faunas of North America. *U.S.G.S. Professional Paper,* 83, p.1-254.

Stanley, G.D., 1979. Paleoecology, Structure and distribution of Triassic coral buildups in Western North America. *University of Kansas, Paleontology Contrib*ution, 65.

Thenius, V.E., 1980. Zum Problem der "zirkumpazzifischen" und der Tethys-Verbreitung mariner Evertebraten in der Trias. *Annalen des Naturhistorisches Museum Wiena,* 83, p.285-301.

Tozer, E.T., 1967. A standard fo Triassic time. *Geological Survey of Canada Bulletin,* 156, 103 pp.

Tozer, E.T., 1979. Latest Triassic ammonoid faunas and biochronology, Western Canada. *Current Research Part B, Geological Survey of Can*ada, 79-1B, p.127-135.

Tozer, E.T., 1984. The Trias and its ammonoids: the evolution of a time scale. *Geological Survey of Canada, Miscellaneous Report,* 35, 171 pp.

Trechman, C.T., 1918. The Trias of New Zealand. *Quarterly Journal of the Geological Society of London*, 73(3), p.165-246, 9 plates, map, sections.

Vinassa de Regny, P., 1915. Triadische Algen, Spongien, Anthozoen und Broyozoean aus Timor. *Paläontologie von Timor*, 4, p.73-118, 10 Tafel, 3 Textfigures.

Vu-Khuc, Dagyx, A.X., Dagys, A.S., Kiparisova, V.D., Nguyen, N.B., Bao, T.C., and Srebrodolskaia, I.N., 1965. Les Fossiles caracteristiques du Trias du Nord Viêt-Nam. *Direction Générale de Géologie de la R.D.V. Hanoi.*

Wanner, J., 1907. Trias petrefakten der Molukken und des Timor archipels. *Neues Jahrbuch fur Miner*alogie, *Geo*logie, *und Paläontologie, Beil BD* 24, p.161-220, 6 Tafel, 4 Textfigures.

Wanner, J., 1910a. Beiträge zur geologischen Kenntnis der Insel Misol (Niederländisch Oost-Indien). *Nederlandsch Aardrijkskunde Genootschaap Tijdschrift,* 27, p.469-500.

Wanner, J., 1910b. Einige geologische Ergebnisse einer im Jahre 1909 ausgefuhrten Reise durch den oostlichen Teil des indoaustralischen Archipels. Vorlaufige Mitteilung. *Central-blad Mineralogie, Geologie, und Paläont*ologie, 22, p.736-741.

Wanner, J., 1911. Trias Cephalopoden von Timor und Rotti. *Neues Jahrbuch fur Mineralogie, Geologie, und Paläontologie, Beil BD* 31, p.177-196, 2 Tafel.

Wanner, J., 1931. Mesozoikum. *Leidsche Geologische Mededeelingen,* 5, p.567-609.

Wanner, J. and Knipscheer, H.C.G., 1951. Der Lias der Niefschlucht in Oost-Seram (Molukken). *Eclogae Geologicae Helvetiae*, 44(1), p.1-28.

Wanner, J., Knipscheer, H.C.G., and Schenk, E., 1952. Zur Kenntnis der Trias de Insel Seram (Indonesien). *Eclogae Geologicae Helvetiae*, 45.

Welter, O.A., 1914. Die Obertriadischen Ammoniten und Nauliden von Timor. *Paläontologie von Timor,* 5, p.1-258, 36 Tafel.

Welter, O.A., 1915. Die Ammoniten und Nautiliden der Ladinischen und Timor. *Paläontologie von Timor,*1, p.1-258, 36 Tafel.

Welter, O.A., 1922. Die Ammoniten der Unteren Trias von Timor. *Paläontologie von Timor*, 11, p.82-159, 17 Tafel.

Wiedmann, J., Fabricius, F., Krystyn, L., Reitner, J., and Urlich, M., 1979. Über umfang ung Stellung des Rhaet. *Strati*graphy *Newsletter*, 8(2), p.133-152.

Wilckens, O., 1927. Paleontology of the New Zealand Trias. *New Zealand Paleontological Bull*etin, 12, Govt. Printer, Wellington.

Yabe, H. and Sato, S., 1942. A new bivalve from the Jurassic Torinosu series of the Abukuma mountainland. *Proceedings of the Imperial Academy, Tokyo*, 18(5), p.251-254.

Yi-kang, W. and Guo-xiong, H., 1976. Triassic Ammonoids from the Mount Jolmo Lungma Region. A report of Science. Expedition In the Mount Jolmo Lungma Region (1966-1968). *Paleontology,* 3, p.459-521.