The Otapirian Stage of the Triassic System of New Zealand
Part I

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Abstract

THE Otapirian Stage is defined, a description is given of the sequence at the type locality, Otapiri Valley, western Hokonui Hills, Southland, and species described from Otapirian localities are listed

INTRODUCTION

THE type locality of the stratigraphic unit formerly known as the Otapiri Series, now the Otapirian Stage (as defined by Marwick, 1953, p. 18), lies in the Otapiri Valley, western Hokonui Hills, Southland. The section exposed along Otapiri Stream (which includes most of the type section) received detailed treatment by Cox (1878) and McKay (1878), but a re-examination of it is nevertheless timely. First, the exact geographic—and hence stratigraphic—positions of some of McKay's localities are not clear from the descriptions. Secondly, the systematic work of Trechmann and Marwick by no means exhausts the fauna known from other Otapirian localities. Some undescribed forms could be useful for correlation elsewhere if their positions in the type sequence were known. Coombs (1950, p. 439) noted a "large and handsome *Lima*" from the Otapirian beds in the northern Taringatura Hills. The same form is abundantly preserved in the southern Taringaturas. Undescribed pelecypods dominate the Otapirian fauna in the Kaihiku Stream-Puerua River area. That some of these forms might occur in beds at the type locality is suggested by Hector's (1878, p. x) list of 17 Otapirian species other than brachiopods, of which at least 10 remain undescribed. It should be noted that the fauna might have been more fully described had Hector's material been better preserved (Marwick, 1946, p 49).

The field work for this paper was done jointly by the writers, with the willing assistance of Abdullah, a student at the Otago School of Mines. Complete responsibility for the map is accepted by one of us (I. C. McK.) while the definition of the stage and the fossil determinations are entirely the work of the other (J D C).

Fossil localities are referred to by numbers for fossil record forms based on One Mile Sheet districts, the master file being held at the Invercargill Office of the New Zealand Geological Survey.

HISTORICAL

The first record of the term "Otapiri Series" is found in the catalogue of the Colonial Museum for 1870. Here, Hector (p. 195) listed genera occurring

at two localities: "Middle Series, of Otapiri Creek" and "Morley Creek, Southland." From this brief account it is apparent that the unit as first conceived was broader than the Otapiri Series of Cox and later workers.

In classifying 76 beds recognized in the Hokonui Hills, Cox (1878, table facing p. 28) grouped beds 38 to 49 inclusive as Otapiri Series of Liassic age (p. 37). In describing the series (pp. 44–5), he noted that the "highly fossiliferous" beds (which he termed "*Trigonia* beds") were "characterized by the occurrence of certain *Spirifers, Trigonia,* and . . . *Belemnites otapiriensis* Hector . . . and by the absence of *Ammonites* from the Bastion series and *Monotis* from the Wairoa series" For the north-west corner of the Hokonui Hills he noted the development of the series "between the Benmore and Oreti [Dipton] railway stations . . . through the southern slopes of Benmore Hill [from whence] it then crosses the Otapiri, the highest bed, Taylor's crossing grit, being found where the Mataura track crosses. From there Taylor's Creek is approximately its higher boundary. . . . The average thickness of these beds is 1,650 feet . . " In the summary (pp. 46–7) he stated "between the *Monotis beds* of the Wairoa series and the beds with *Belemnites otapiriensis,* Hect.: at the base of the Otapiri Series, a palaeontological unconformity probably exists, a distinct break in the character of the fossils occurring on this line."

Marwick (1953, p. 59) attributed the description of *Otapiria dissimilis* (Cox) to Cox (1878, p. 45).

Hector (1878, p. vii) designated 1,600 feet of beds in the Hokonui Hills as Otapiri Series of Rhaetic age. In provisional notes on the series (p. x), he commented on the "mixed character" of the fossils, among which he recognized Oolitic, Liassic and Permian species as well as Triassic, and on the abundance of brachiopods, "chiefly peculiar forms." He named *Clavigera* and *Rastelligera* as new brachiopod genera to accommodate these forms, but no species being cited by him here or in a further publication (1878b), these remained *genera caeliba.*

McKay (1878, pp. 87-9) listed fossils—mainly as genera—collected by him from 14 Otapirian localities in the Hokonui Hills. Two of these are in the type section of the stage, *viz* · G S.362, "Taylor's Crossing, Otapiri Creek," bed 49 with:

Ammonites
Cypricardia
Halobia ?
Spirifer (2 sp)
Spirigera
Terebratula, etc.

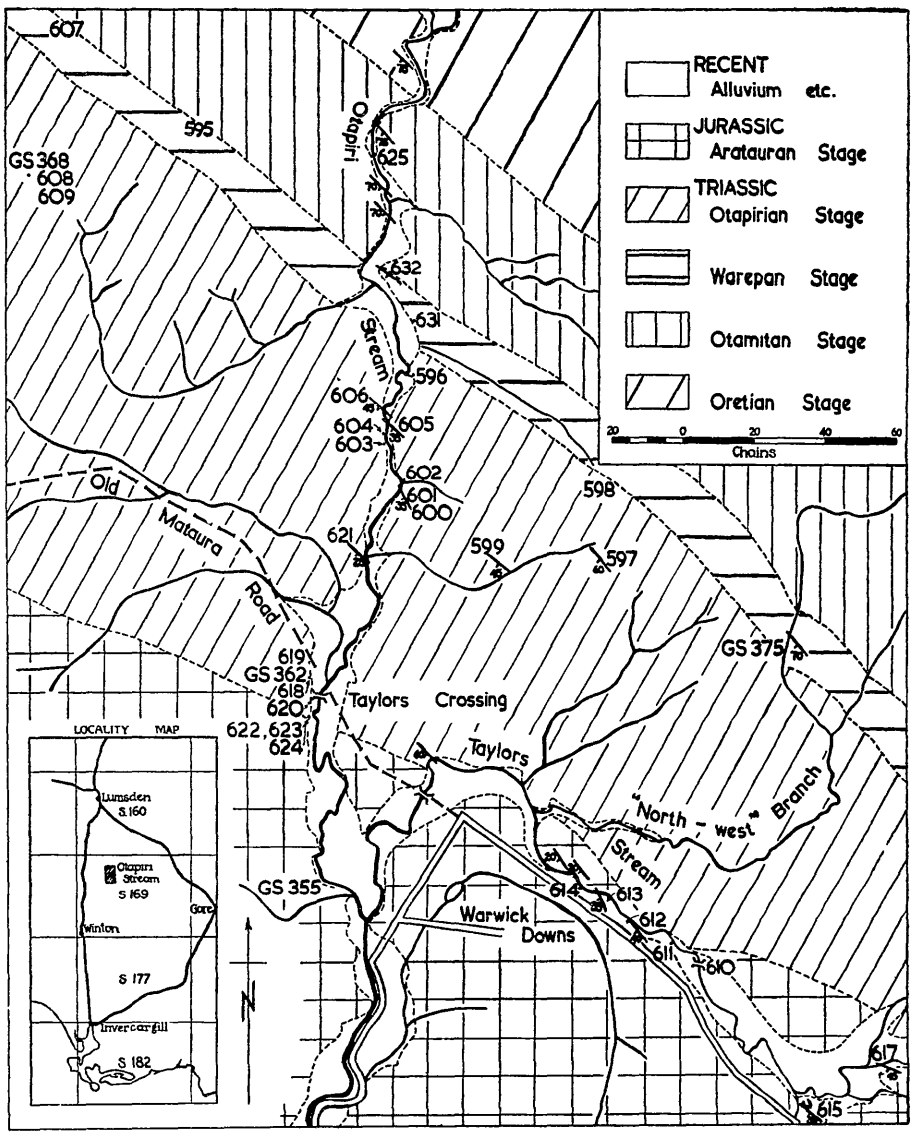
and G.S.367, "In the west bank of Otapiri Creek, half a mile above Taylor's Crossing," bed 46 with:

Spirifer (2 sp.)
Rhynchonella (2 sp)

Hector (1878a) described *Aulacoceras otapirense* (Hector) from an Otapirian locality at Dipton railway cutting.

McKay (1881. p. 44) listed 4 species from an Otapirian locality on the east bank of the Mataura River, near Gore Two of these·

Spiriferina spatulata Hector
Rastelligera taylori Hector



TEXT-FIG. 1.—Geological map of the Otapiri Valley, N.W. Hokonui Hills, Southland.

are *nomina nuda* being MS. names only. The former name was again published also without description or figure by Hector in 1884 (p. xxxviii).

Park (1910, pp. 61, 72) included within the Otapiri Series the two divisions *Clavigera* beds and *Mytilus* and *Monotis* beds.

Thomson (1913, p. 15, footnote) appears, on the basis of Marshall's information on the locality from which *Proclydonautilus mandeville* (Marshall) and *Arcestes hokonui* Marshall were described, to have accepted these fossils as belonging to the Otapiri Series. (It can now be stated that the locality is Otamitan). In a census of pre-Cretaceous fossil invertebrates of New Zealand, Thomson (p. 33) included a single valid species (*Atractites otapiriensis* (Hector)) from

the Otapiri Series It should be noted here that two *nomina nuda* included in the census (*Clavigera tumida* Hector and *Monotis dissimilis* Hector), have since been validated. In an attempt to validate formally the genera *Clavigera* and *Rastelligera,* he published figures and type localities for the following MS. species of Hector: *C bisulcata, C. cuneiformis, C. gracilis, C. tumida* and *R elongata.* The localities (G.S.371. 366 and 368) were all termed Rhaetic, and are in fact all Otapirian. In a later publication. Thomson (1919, p. 412) assumed responsibility for the species which were cited thus: "*Rastelligera elongata* Thomson, 1913."

Trechmann (1918) described 6 species of brachiopods from Otapirian localities. He renamed the genus *Clavigera*, rejected the genus *Rastelligera* and ignored the species cited by Thomson in 1913. Four of the species described by Trechmann passed into synonymy therefore with the publication of Thomson's 1919 paper Those retained were *Spiriferina gypaëtus* Trechmann and *Mentzelia kawhiana* Trechmann. Trechmann compared an Otapirian ammonite with *Arcestes rhaeticus* Clark and a brachiopod with *Mentzelia ampla* Bittner. He confirmed a Rhaetic age for the Otapiri Series (p 167) but suggested that the upper part of Noric time may also be represented. In a table (facing p. 237) he included—perhaps inadvertently—horizons with *Halobia* and *Monotis* in the series The same author (1923, p 273) recorded *Pteria* cf. *contorta* (Portlock) from an Otapirian locality in Southland, and in 1930 described *Atlantobellerophon zealandicus* Trechmann from a Nelson locality that is probably Otapirian in age.

Allan (1945, p 10) declared *Clavigera gracilis* Thomson synonymous with *C. tumida* Thomson

Marwick (1946, pp. 29–30) reviewed the Otapiri Series, and for the Marakopa coastal section included in it beds with "three well defined forms of *Monotis.*"

In 1951 the same author proposed a new classification for rocks of the Hokonui System, the Otapirian Stage being equivalent to the old unit Otapiri Series. Balfour Series was set up to include the Otamitan, Warepan and Otapirian Stages Fossils listed for the Otapirian Stage were:

Clavigera bisulcata
Rastelligera elongata
Arcestes rhaeticus

The last named species was referred by Marwick in 1952 (p. 30) to *Rhaetites*, a genus placed in synonymy with *Arcestes* by Spath (1951, p. 129).

The new classification was amplified in the comprehensive bulletin on the Hokonui System published by Marwick in 1953. He defined the type locality for the stage and listed 7 species occurring there. Species from other Otapirian localities were mentioned, and the stage was said to be characterized by the "common occurrence of *Clavigera* and *Rastelligera* Neither is confined to it, but beds containing the two in quantity are almost sure to be Otapirian " Two new species were described: *Torastarte bensoni* Marwick from an undoubted Otapirian locality in the Hokonui Hills and *Monotis calvata* Marwick from a bed at Marakopa considered by Marwick to be Otapirian

Fleming (1953) recorded the oyster, *Lopha* cf *haidingeriana* (Emmrich) from an Otapirian locality 12 miles west of Huntly, Auckland.

DEFINITION

The Otapirian Stage is defined as those rocks laid down at the type locality from the first appearance of *Spiriferina (Rastelligera) diomedea* Trechmann until the appearance of a fauna including psiloceratid ammonites. In stratal terms this consists of 4,000 feet of sandstone, siltstone and fine conglomerate between the localities S169/598 and S169/624 It should be noted that the thickness cannot be estimated accurately because of varying dips; the figure given could be in error by 500 feet.

It is clear from McKay's writings that forms other than *S (Rastelligera) diomedea* were often—perhaps most often—used in mapping the base of the unit. *Myophoria* sp (giving the name "*Trigonia* beds") was one of these (McKay, 1879, p 119; 1881a, p. 106) but this seems to have been used only in the apparent absence of *Aulacoceras otapiriense* (Hector). The latter form, though by no means abundant, has the advantage of being distinct from any other New Zealand Triassic fossil

S. (Rastelligera) diomedea is selected as the key fossil for the following reasons:

1. It occurs in the type section.

2 It is easily recognized in the field and is readily separated from the relatively rare species of *Rastelligera* occurring in Warepan beds

3. Its appearance in time in the western Hokonui-Taringatura region at least, seems to have coincided with the incoming of *A. otapiriense* and of a number of other species.

4. It is widely distributed.

It is appropriate to mention here the standing of *S. (Rastelligera) diomedea* as a species. Apart from suspected morphological differences, it is unsafe on stratigraphic grounds to accept Thomson's synonymy of the species with *S. (Rastelligera elongata* (Hector) It will be seen in Part II of this paper that the type locality of *diomedea* (Roaring Bay, Nugget Point) is to be correlated with the base of the Otapirian Stage, while the horizon from which *elongata* was described has long been considered as forming the uppermost bed of the stage.

The following forms are restricted to Otapirian beds at the type locality of the stage.

Mentzelia kawhiana Trechmann
Spiriferina (Rastelligera) elongata (Hector)
S. (Rastelligera) diomedea Trechmann
S (Rastelligera) gypactus Trechmann
Clavigera tumida Hector
C. cuneiformis Hector (not of Trechmann)
Myophoria sp.
Pteria cf. *contorta* (Portlock)
Otapiria dissimilis (Cox)
Chlamys sp
Lima sp
Aulacoceras otapiriense (Hector)

Several undescribed pelecypods and brachiopods, a nautiloid and crinoids qualify for inclusion here

The following are among those forms restricted to beds that are Otapirian by correlation:

Mentzelia cf. *ampla* Bittner
Spiriferina sp. (*S. spatulata* of Hector)
S. (Psioidea) sp.
S. (Rastelligera) sp.
Anodontophora sp.
Triaphorus sp.
Torastarte bensoni Marwick
Arcestes cf. *rhaeticus* Clark

Type Locality

The type locality of the Otapirian Stage lies in the Otapiri Valley, upstream from the Taylors Stream junction; for much of its length the type section follows along the Otapiri Stream. The rocks have a general north-westerly strike and they dip to the S.W at angles ranging from 70° to 25°. Outcrops occur as low rocky banks beside the Otapiri Stream and occasionally form bars in it. There are several gaps in the section which preclude great accuracy in estimating thicknesses. The choice of locality was however a happy one, for every outcrop proved fossiliferous.

The bed in which *Spiriferina (Rastelligera) diomedea* first appears does not crop out beside the Otapiri Stream; it occurs on the south facing slope 58 chains E. of the stream (S169/598). Its approximate position in the stream section is that of the strike stream joining the Otapiri from the east between two prominent hard bands that are ridge formers in this part of the valley (McKay. 1878, p. 69), a little over a mile upstream from the bridge at Taylors Crossing The lower coarse bed crops out at stream level and can be traced along the strike in either direction. It contains *Monotis richmondiana* in abundance in a locality (S169/595) 45 chains west of the stream, on a track on the crest of a ridge between two patches of bush. The same fossil was collected from the summit ridge of the south peak of Benmore (S169/607). Both these localities were known to McKay, who also collected *M. richmondiana* from the N.W. branch of Taylors Stream (1878, p. 69). Fragments of the same fossil have been found recently in two new localities within a few chains of the Otapiri (S169/631, 632)

The higher of the two hard bands referred to above crops out 90 chains upstream from the bridge; it consists of coarse sandstone and fine conglomerate, and contains *S. (Rastelligera) diomedea* (S169/596).

A break in the section is followed by a series of outcrops of hard sandstones that form rapids in the stream between 70 and 80 chains upstream from the bridge. The following fossils occur in the lower part of the group of outcrops (S169/606, 605, 604):

Spiriferina (Rastelligera) diomedea Trechmann
Clavigera tumida Hector
Anodontophora sp.

An undescribed species of *Lima* makes its appearance in the highest part of the group of outcrops (S169/603). Coombs (1950, p 439) recorded a similar form from lower Otapirian beds in the Taringatura Hills

The next exposure, separated from the last by a break in the section, occurs on the left bank of the stream three-quarters of a mile upstream from the bridge (S169/602, 601, 600). In a faunule that includes the brachiopods mentioned above for lower beds, the following make their appearance:

"Rhynchonella" sp.
"Terebratula" sp.
Pteria sp. (cf Trechmann, 1923)
Pleurotomaria sp.
crinoid

At about this horizon *Myophoria* sp. was collected at a locality (S169/599), 30 chains E of Otapiri Stream on the W. side of a S W. flowing tributary gulley. This is presumably *Trigonia vulgaris* of Hector and is widely distributed in beds of lower Otapirian age.

A gap in the stream section is followed by an outcrop (S169/621) on the right bank of the Otapiri, 40 chains upstream from Taylors Crossing bridge. There is little doubt that this is G.S.367, bed 46 of McKay (1878, p. 88) although subsequent reference has been made to McKay's locality as being one mile above Taylors Crossing (appendix to *R G E No 11*, 1878, pp. 196, 203, 209; Thomson, 1913, p 90). The following make their first appearance in the bed, which also contains *Clavigera tumida* and *Myophoria* sp :

"Rhynchonella" sp.
Spiriferina (Rastelligera) gypaetus Trechmann
Otapiria dissimilis (Cox)
nautiloid

O dissimilis and *C tumida* are common in beds above the present horizon; along with the rhynchonellid they form the characteristic assemblage of the upper Otapirian beds at Kawhia (see Part II).

A locality thought to be G S. 368 is about the same horizon as that just described. The outcrop is 100 chains W. of Otapiri Stream, on the north face of a knob on the spur that leads from the south peak of Benmore, south and then east to the stream G S.368 is the type locality of *S (Rastelligera) gypaetus* Trechmann and of *Torastarte bensoni* Marwick The following are also present (S169/608) ·

"Terebratula" sp.
Mentzelia kawhiana Trechmann
Clavigera tumida Hector
Myophoria sp
Conularia sp.

The next outcrop met with in the stream section is at Taylors Crossing where, in the lower 2 feet of a rocky bank 6 feet high in a cutting on the old Mataura road, the following are preserved in great numbers ·

Clavigera tumida Hector
Otapiria dissimilis (Cox)

The bed, known as G S 362, bed 49 of McKay, is composed of fine sandstone (S169/619), and is overlain by a coarse sandstone making up the upper 4 feet of the bank. The coarser bed (S169/618) was termed Taylors Crossing Grit by Cox and McKay; it contains abundant fragments of *S (Rastelligera) elongata* (Hector) and *C tumida* along with rare *O. dissimilis* and *M. kawhiana.*

The remaining 400 feet of beds of the stage are mostly fine sandstone and siltstone cropping out as stream bluffs south of Taylors Crossing. Only *C. tumida* and *O dissimilis* were found in these outcrops (S169/620, 622, 623).

In a bluff 5 chains south of Taylors Crossing swing bridge, a new fauna enters. The boundary between beds containing the two assemblages, here taken as the

Otapirian-Aratauran boundary, is clearly marked at the south end of the bluff where the stream swings sharply eastwards. *C. tumida* and *O. dissimilis* were collected within inches of the new fauna which contains *Pleuromya* sp. and crushed pelecypods (S169/624). Psiloceratid ammonites have not so far been collected from this bluff although, from experience further east, they might be expected here. They are known from higher horizons, such as G.S.355, further south.

The Otapirian-Aratauran boundary crosses and re-crosses Taylors Stream 1½ miles S.E. of Taylors Crossing. Otapirian beds with abundant fossils crop out on the left bank of the stream (S169/611) 8 chains downstream from the upper swing bridge. The following forms occur:

"Rhynchonella" sp.
Mentzelia kawhiana Trechmann
Clavigera tumida Hector
Otapiria dissimilis (Cox)

Marwick (1953, p. 59) recorded the last named fossil from G.S.5145, 60 yards below the upper swing bridge.

On passing downstream from S169/611 the next overlying fossiliferous bed (S169/612) contains the following:

"Rhynchonella" sp.
"Terebratula" sp.

Neither species is known from beds lower in the sequence; the rhynchonellid also occurs in siltstone immediately upstream from the upper swing bridge (S169/610). The terebratulid which is probably *Athyris spiculata* of Hector MS. (*fide* Marwick, pers. comm.) is common in beds overlying those with *O. dissimilis*, *C. tumida* and *M. kawhiana*. It was found to occur with psiloceratid ammonites in at least two localities: on the right bank of Taylors Stream, a quarter of a mile upstream from the junction of the N.W. branch (S169/614, almost certainly G.S.358), and on the left bank of Taylors Stream at the junction of the main north tributary (S169/617). The latter locality is a prolific one; the terebratulid and fragmentary ammonites are preserved in abundance along with wood, spicules and rare specimens of *Chlamys* sp.

A satisfactory definition of the Aratauran Stage has yet to be published. When this is done the upper limit of the Otapirian Stage adopted in this paper may well require to be modified.

Faunal Index

No species has been described from the type section of the Otapirian Stage. The following are described from beds that are Otapirian by correlation:

Mentzelia kawhiana C. T. Trechmann, 1918
Spiriferina (Rastelligera) elongata (J. Hector, 1913)
S. (Rastelligera) diomedea C. T. Trechmann, 1918
S. (Rastelligera) gypaëtus C. T. Trechmann, 1918
Clavigera tumida J. Hector, 1886
C. cuneiformis J. Hector, 1886 (not of Trechmann, 1918)
C. bisulcata J. Hector, 1913
Otapiria dissimilis (S. H. Cox, 1878)
Aulacoceras otapiriense (J. Hector, 1878)
Torastarte bensoni J. Marwick, 1953

Atlantobellerophon zealandicus C. T. Trechmann, 1930 almost certainly qualifies for inclusion here, but there is considerable doubt as to the age of the bed from which *Myophoria heslingtonensis* C T. Trechmann, 1918 was described. The type locality of *Monotis calvata* J Marwick, 1953 is thought to be Warepan in age

Figures and descriptions have been published of the following species, the specimens in each case being collected from beds that are Otapirian by correlation.

Mentzelia cf *ampla* A. Bittner, 1890. (Trechmann, 1918)
Pteria cf *contorta* (J E Portlock, 1843). (Trechmann, 1923)
Lopha cf. *haidingeriana* (A Emmrich, 1853). (Fleming, 1953)
Arcestes cf *rhaeticus* W. B. Clark, 1888. (Trechmann, 1918).

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