

Otoliths of Fishes, from the Tertiary Formations of New Zealand, and from Balcombe Bay, Victoria.

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THE following is a description of a collection of fossil otoliths, received from Dr. H. J. Finlay, of the University of Otago, to whom I am also indebted for a list of the formations in their proper sequence, and the estimated ages of the beds from which they were obtained. These are as follows:—

OTOTARAN.	Oligocene.
Waikaia.	
Wharekuri.	
Clifden (bands 4 and 6). (? Probably basal Hutchinsonian.)	
HUTCHINSONIAN.	Oligocene or lower Miocene.
Clifden (band 7).	
Otiake.	
LOWER AWAMOAN.	Miocene.
Clifden (band 8)	
Target Gully.	
Ardgowan.	
UPPER AWAMOAN.	Miocene.
Awamoa.	
Pukeuri.	
Rifle Butts.	

There are 5 new forms of otoliths, of which 4 belong to the family Congridae, and one is referred to the Cottidae; there is a good example of *Elops miocaenicus* Frost, and eleven other species from New Zealand and two from Victoria, corresponding with forms which have been described from the tertiaries of Europe.

As has been previously pointed out, the value of fish-remains from a stratigraphical point is necessarily slight, and this is especially so in the case of otoliths, owing to the persistence of the separate forms throughout the different epochs. It is, however, of interest to note that of the eleven species corresponding with European tertiary forms, only 1 has been described from the Pliocene, 7 from the Miocene, 4 from Oligocene formations, and 1 only from the Eocene.

The accompanying chart shows the formations in the ascending scale, the occurrence of species now described is indicated by a cross, and if figured in a previous paper by a double cross.

STRATIGRAPHICAL ARRANGEMENT, SHOWING INCIDENCE OF OCCURRENCE.

Age	Oligocene or Lower Miocene					Miocene			Miocene		
Formation	Ototaran			Hutchinsonian		Lower Awamoan			Upper Awamoan		
Locality	Waikaia	Wharekuri	Clifden Bands 4&6 4B 6A 6C	Clifden Band 7	Otiake	Clifden Band 8	Target Gully	Ardgowan	Awamoan	Pukeuri	Rifle Butts
Fig. 1	+	+	...	+
" 2	+	+	+
" 3	+
" 4	+
" 5, 6 ...	±	+	...	+	±	+
" 8	+	+	±	...
" 9	+
" 10	+
" 11	+
" 12	+
" 13
" 14	+
" 15	+	±	...
<i>Scopelus sulcatus</i>	+	±	±	±	±	...
<i>Macrurus toulai</i>	±	±	±	±	(also from Tuhua & White Rock River)
<i>Pagellus gregarius</i> ..	±	+	±
<i>Fierasfer nuntius</i> ...	±	...	+	+	+

+ Now described.

± Previously described.

Otolithus (Congeris) wharekuriensis n. sp. (Fig. 1.)

Description.—Dimensions 9×6 mm. Shape elliptical, biconvex, dorsal rim domed, ventral rim curved, posterior rim pointed, anterior rim rounded. Sulcus wide, undivided, oblique, open on anterior part of dorsal rim, cauda with rounded end, does not approach posterior rim.

Material.—16 examples Wharekuri, 3 ex. Clifden, band 6a, 6 ex. Otiake.

Distribution.—Lower Miocene or Oligocene of Wharekuri and Clifden.

Remarks.—Resembles *Otolithus congeris papointi* Priem described from the Eocene (Ypresian) of Herouval, France (*Bull. Soc. Geol. de France*, vol. 6, p. 274, 1906). It differs in the more elongated shape, in the undivided lower line of the sulcus, and in the pointed posterior rim.

Otolithus (Congeris) rectus n. sp. (Fig. 2.)

Description.—Dimensions 6 mm. $\times 3\frac{1}{2}$ mm. Shape ovate, elongate, biconvex, dorsal rim low, straight, forms rounded angle with the oblique anterior rim; ventral rim curved, posterior and anterior rims obtusely pointed. Sulcus oblique, undivided, open on anterior part of dorsal rim.

Material.—2 ex. Otiake, 1 ex. Clifden band 4B, 4 ex. Clifden band 6C, 1 ex. Clifden band 7B.

Distribution.—Lower Miocene or Oligocene of Otiake and Clifden.

Remarks.—This species resembles *Otolithus (Congeris) wharekuriensis* in the sulcus; it differs in the low straight dorsal rim and in the posterior rim. The shape is more elongated, and the posterior of the otolith is narrower than the anterior part.

Otolithus (Congridarum) clifdenensis n. sp. (Fig. 3.)

Description.—Dimensions 7 mm. $\times 5$ mm. Shape irregular, highest anteriorly, biconvex, dorsal rim flat medially, oblique in its anterior and posterior parts, ventral rim deeply keeled anteriorly, oblique posteriorly, posterior rim obtuse, anterior rim oblique, with blunt angle. Sulcus straight, parallel with middle of dorsal rim, ends near the centre, ostial part shallow and ill defined.

Material.—The holotype, Clifden, band 6A.

Distribution.—Lower Miocene or Oligocene of Clifden, New Zealand.

Remarks.—The shape of the otolith resembles that of the recent genus *Conger muraena* in the anterior depth of the ventral rim; it differs in the dorsal rim, also in the sulcus which is similar to that of *Uroconger*.

Otolithus (Congridarum) ornatus n. sp. (Fig. 4.)

Description.—Dimensions 4 mm. $\times 2\frac{1}{2}$ mm. Shape ovate, biconvex, dorsal rim low, irregular, ventral rim keeled anteriorly, posterior and anterior rim bluntly pointed, with praesulcal area; sulcus broad, curved and short, ostium distended and enclosed anteriorly, with narrow opening to anterior part of dorsal rim. A band extends from the ostium along the ventral and posterior rims.

Material.—The unique holotype from Clifden, band 6A.

Distribution.—Lower Miocene or Oligocene of Clifden, New Zealand.

Remarks.—Resembles the otoliths of *Otolithus (Congeris) wharekuriensis* in general; it differs in the irregularity of the rims, especially in the anterior depth of the ventral rim, also in the curved sulcus and in the praesulcal area.

Otolithus (Dentex) aff. subnobilis Sch. (Figs. 5, 6.)

Description.—Dimensions $3\frac{1}{2}$ mm. \times $2\frac{1}{2}$ mm. Shape ovate, sulcus straight, ostium small, cauda long, pointed, does not reach posterior rim.

Material.—3 ex. Wharekuri, 1 ex. Ardgowan.

Distribution.—Lower Miocene or Oligocene of Wharekuri, Miocene of Ardgowan.

Remarks.—Described by Schubert from the tertiaries of Austro-Hungary (*Jahrb. der K.K. Geol. Reichsanst.*, vol. 56, p. 263, 1906). Also by Priem from the Miocene (Burdigalien) of Martillac and Leognan, S.W., of France (*Bull. Soc. Geol. de France*, vol. 14, p. 263, 264, 1914), and from Waikaia, Ardgowan, and Pukeuri, New Zealand, by Frost (*Transactions of the New Zealand Institute*, vol. 55, p. 613, 1924).

Otolithus (Monocentris) Lemoinei Priem (Figs. 7, 7a.)

Description.—Dimensions 9 mm. \times 7 mm., 8 mm. \times 7 mm.

Material.—3 large examples.

Distribution.—Eocene of Balcombe Bay, Victoria.

Remarks.—Described from the Eocene of Reims by Maurice Leriche (*Ann. Soc. Geol. du Nord*, Tome 37, p. 246; Pl. 6, figs. 7, 7a, 8, Lille, 1908).

Otolithus (Percidarum) plebejus Koken. (Fig. 8.)

Description.—Dimensions 4 mm. \times $2\frac{1}{2}$ mm.

Material.—2 examples Clifden band 6A; 6 examples Clifden band 6C.

Distribution.—Lower Miocene or Oligocene of Clifden, New Zealand.

Remarks.—Described by Koken from the Middle Oligocene of Waldbockelheim. (*Zeit. d. deut. Geol. Gesell.*, Bd. 43; Taf. 10, Fig. 1).

Otolithus (Percidarum) frequens Koken. (Fig. 9.)

Description.—Dimensions 4 mm. \times $3\frac{1}{2}$ mm.

Material.—5 examples Otiake; 6 examples Clifden, band 6C.

Distribution.—Lower Miocene or Oligocene of Otiake and Clifden, New Zealand.

Remarks.—Described by Koken from the upper Oligocene of Sternberger Gestein (*Zeit. d. deut. Geol. Gesell.*, Bd. 43; Taf. 8, Fig. 4).

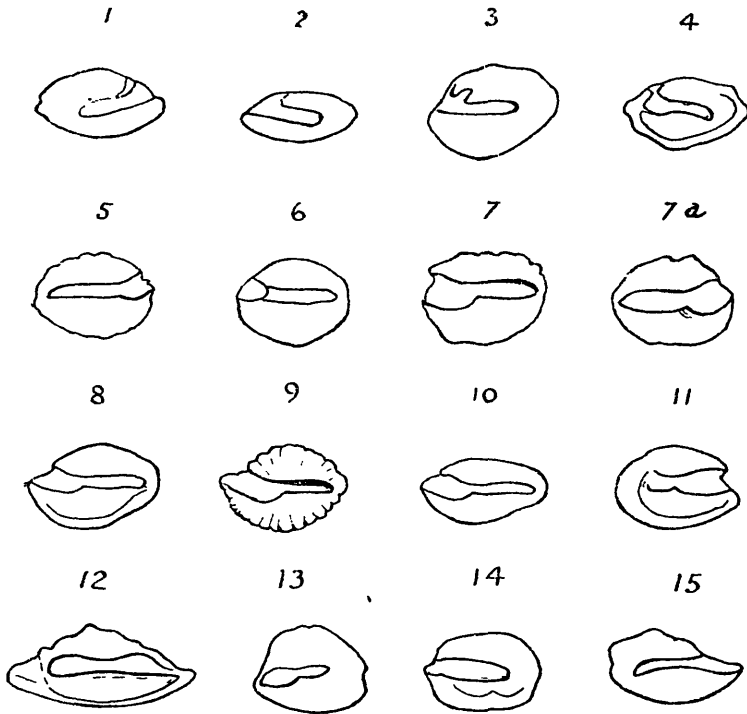
Otolithus (Percidarum) aff. augustus Priem. (Fig. 10.)

Description.—Dimensions $3\frac{1}{2}$ mm. \times 2 mm.

Material.—1 example.

Distribution.—Miocene of Target Gully, New Zealand.

Remarks.—Described by Priem from the Lutetien (Middle Eocene) of Le Bois-Gouet, Loire Inférieure (*Bull. Soc. géol. de France*, vol. 13, p. 155; fig. 7, 1913).



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- FIG. 1.—*Otolithus (Congeris) wharekuriensis* n. sp. \times 2.
 FIG. 2.—*Otolithus (Congeris) rectus* n. sp. \times $2\frac{1}{2}$.
 FIG. 3.—*Otolithus (Congridarum) clifdenensis* n. sp. \times $2\frac{1}{2}$.
 FIG. 4.—*Otolithus (Congridarum) ornatus* n. sp. \times 4.
 FIGS. 5, 6.—*Otolithus (Dentex) aff. subnobilis* Schubert. \times $4\frac{1}{2}$.
 FIGS. 7, 7a.—*Otolithus (Monocentris) Lemoinei* Priem. \times 2.
 FIG. 8.—*Otolithus (Percidarum) plebejus* Koken. \times 4.
 FIG. 9.—*Otolithus (Percidarum) frequens* Koken. \times 4.
 FIG. 10.—*Otolithus (Percidarum) aff. augustus* Priem. \times $4\frac{1}{2}$.
 FIG. 11.—*Otolithus (Scopelus) pulcher* Prochazka. \times $4\frac{1}{2}$.
 FIG. 12.—*Otolithus (Cottus) otiakensis* n. sp. \times 8.
 FIG. 13.—*Otolithus (Pleuronectidarum) splendens* Schubert. \times 6.
 FIG. 14.—*Otolithus (Solea) Kokeni* Bass & Schubert. \times 7.
 FIG. 15.—*Otolithus (Elops) miocaenicus* Frost. \times $3\frac{1}{2}$.

Otolithus (Scopelus) pulcher Prochazka. (Fig. 11.)

Description.—Dimensions $3\frac{1}{2}$ mm. \times 2 mm.

Material.—2 examples.

Distribution.—Miocene of Ardgowan, New Zealand.

Remarks.—Described by Prochazka from the Miocene of Seelowitz in Mahren (*Sitzungsber d. boh. Franz-Joseph Akad.*, 24, Prag. 1893), by Priem from the Pliocene of d'Aleria, Corsica (*Bull. Soc. geol. de France*, vol. 11, 1911), and by Bassoli from the Miocene of Monte Gibio, Italy (*Riv. Ital. di Paleont.*, Anno 12, Fasc 1, p. 50, Perugia, 1906).

Otolithus (Scopelus) sulcatus Prochazka.

2 examples from the Hutchinsonian of Clifden, examples described by the author from Tuhua, North Island, Pukeuri, Awamoa, White Rock River, Ardgowan, Target Gully (*Trans. New Zealand. Inst.*, vol. 55, p. 607, 1924).

Otolithus (Maxrurus) toulai Schubert.

3 examples from the Miocene (Awamoan) of Rifle Butts; 1 example from Ardgowan; 1 example from the Eocene of Balcombe Bay, Victoria.

Previously described by the author from Pukeuri, Awamoa, Ardgowan, Target Gully (*ibid.*, p. 608).

Otolithus (Cottus) otiakensis n. sp. (Fig. 12.)

Description.—Dimensions 3 mm. \times 1½ mm. Shape elongate, outer side concave, inner side convex, dorsal rim serrated, highest medially; ventral rim curved, posterior rim short, vertical; anterior rim pointed, rostrum, no antirostrum or excisura. Sulcus biovate. enclosed, with median constriction. Rostrum, posterior area, and band above ventral rim, lower than the central area of the inner side.

Material.—3 examples including holotype.

Distribution.—Lower Miocene or Oligocene of Otiake, New Zealand.

Remarks.—This otolith resembles the sagitta of the recent species *Cottus gobio* of the family Cottidae, the outline being identical, and the sulcus very similar.

Otolithus (Pleuronectidarum) splendens Schubert. (Fig. 13.)

Description.—Dimensions 2½ mm. \times 2½ mm.

Material.—1 example.

Distribution.—Miocene of Ardgowan, New Zealand.

Remarks.—Described by Schubert from the Miocene of Voslau (*Jahrb der K.K. Geol. Reichsanst.*, 56, p. 263, Wien., 1906).

Otolithus (Solea) Kokeni Bass and Schubert. (Fig. 14.)

Description.—Dimensions 2 mm. \times 1½ mm.

Material.—1 example.

Distribution.—Miocene of Target Gully, New Zealand.

Remarks.—Described by Bassolo, from the Middle Miocene of Monte Gibio, Modena. (*Riv. Ital. di Paleont.*, Anno 12, Fasc 1, p. 45; Tav. 11, Fig. 3, Perugia, 1906).

Otolithus (Elops) miocaenicus Frost. (Fig. 15.)

Description.—Dimensions 5 mm. \times $2\frac{1}{2}$ mm.

Material.—1 example.

Distribution.—Lower Miocene or Oligocene of Clifden, band 6 C, New Zealand.

Remarks.—Described by the author from the Miocene of Pukeuri, New Zealand (*Trans. New Zealand Inst.*, vol. 55, p. 612, 1924).

Otolithus (Pagellus) gregarius Koken.

Material.—3 examples from the Oamaru series of Wharekuri.

Remarks.—Examples previously described from Waikaia and Clifden (*Trans. New Zealand Inst.*, vol. 55, p. 613, 1924). First figured by Koken from the Upper Oligocene of Sternberger Gestein (*Zeit. der deut. Geol. Gesell.*, vol. 43, Taf. 7, Figs. 7, 7a), also noted by Priem from the Miocene (Burdigalien) of South West France (*Bull. Soc. geol. de France*, 4th series, tome 45, p. 266, 1914).

Otolithus (Fierasfer) nuntius Koken.

7 examples from Clifden, bands 6C, and 6A, and 3 from Otiake (Lower Miocene or Oligocene). Previously described from the Oamaru series of Waikaia (*ibid.*, p. 611), also by Koken from the Middle Oligocene of Sollingen (*Zeit. der deut. Geol. Gesell.*, Bd. 43; Taf. 6, Figs. 2, 2a).