Otoliths of Fishes from the Tertiary Formations of New Zealand.

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Communicated by Professor W. N. Benson.*

[*Read before the Otago Institute, 13th November, 1923; received by Editor, 3rd December, 1923; issued separately, 28th August, 1924.*]

Plates 61, 62.

THE material for the following paper, which I received through the kindness of Professor W. N. Benson, of the University of Otago, Dunedin, consisted of fifty-six specimens of otoliths, the property of the Geological Survey of New Zealand, and seventy-one otoliths collected by Mr. H. J. Finlay, M.Sc., of the University of Otago, to whom I am also indebted for a list of the formations, in their proper sequence, from which they were obtained. I wish also to acknowledge the great assistance I have received from Professor Benson in his letters, and from the literature he has so kindly sent me on the present nomenclature and correlation of the various systems of New Zealand.

The list of the localities and probable age of the beds from which the otoliths have been obtained are as follows :—

Oamaru Series—
1. Waikaia (Lower Miocene or Oligocene).
2. Wharekuri (Lower Miocene or Oligocene).
3. Clifden (Lower Miocene or Oligocene).
4. Target Gully (Miocene).
5. Ardgowan (Miocene).
6. White Rock River (Miocene).
7. Awamoa (Miocene).
8. Pukeuri (Miocene).

Mokau Series—
9. Tuhua, North Island (Upper Miocene).

Wanganui Series—
10. Castlecliff (Upper Pliocene).

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* In the valuable paper which follows the author refrains from deducing from the evidence of the fish-remains themselves any conclusions as to the age of the formations in which they occur. It is interesting to recall in this connection that Windhausen (*Amer. Jour. Sci*, vol. 45, p. 46, 1918) quotes with approval von Ihering's view, based on Patagonian experience, of "the slight value of fish-remains for the decision of stratigraphic problems." Australian geologists have had similar experience in connection with the fish-fauna in the Triassic Hawkesbury System, near Sydney. Presumably the evidence of otoliths only would be still less conclusive, and this, Mr. Frost states in a private communication, is his opinion on the matter. The evidence afforded of faunal relationships is, however, very interseting.—W. N. B.

Mr. Finlay informs me that Nos. 4 and 5 are practically the same horizon, that No. 6 is very near to these, while No. 3 is certainly older than No. 4 but younger than No. 2, and that 7 and 8 are possibly identical horizons and slightly younger than 4 and 5. The occurrence of the different species is quite in accord with his observations. The only species submitted from No. 9 occurs in all other formations up to Target Gully, and that from No. 10, which is very much younger than all the others, is found as low as the Waikaia and in several intervening horizons.

In spite of the small amount of material submitted to me, it is evident that the formations from which it was taken are closely connected stratigraphically.

The amount of material from Pukeuri sent me was much in excess of that from any of the other localities, but of the fifteen species determined from Pukeuri there are examples of five from Ardgowan and four from Target Gully, two from Awamoa, and two from White Rock River.

Otolithus (Scopelus) sulcatus Bassoli (Plate 61, fig. 1) occurs in all the formations from Pukeuri to Target Gully, also in the Mokau series at Tuhua, North Island; *Otolithus (Macrurus) 'toulai* Schubert (Plate 61, fig. 4) occurs at Pukeuri, Awamoa, Ardgowan, and Target Gully; while *Otolithus (Ophidiidarum) pantanelli* (Plate 61, fig. 8), occurring at Pukeuri, Ardgowan, Target Gully, and Clifden, extends down to Waikaia with five examples, and upwards to the Upper Pliocene of Castlecliff, North Island, from which there is one example. Numerous examples of *Otolithus (Serranus) noetlingi* Koken (Plate 62, fig. 13) occur at Ardgowan and Pukeuri, also *Otolithus (Dentex) subnobilis* Schubert (Plate 62, fig. 18) occurs at both places, while *Otolithus (Sparidarum) elongatus* Priem is found at Target Gully and at Pukeuri. Waikaia and Clifden both furnish examples of *Otolithus (Sparidarum) gregarius* Koken (Plate 62, fig. 17) and *Otolithus (Ophidiidarum) pantanelli* (Plate 61, fig. 8). Two species are found at both Waikaia and at Pukeuri—*O. (Ophidiidarum) pantanelli* and *O. (Dentex) subnobilis.*

Of the twenty-two species determined, fifteen have been recorded from the Tertiary of Europe, the remaining seven being new species. The otoliths of shore-fishes predominate, with seventeen species, compared with five of the deep sea, the latter being fairly numerous, with twenty-one examples of Scopelidae and fourteen of the Macruridae, though only one of *Citharus.*

Tropical species are represented by *Fierasfer*, *Elops*, and *Citharus*, while others represent a subtropical or temperate fauna.

The genera and number of species determined are as follows:—

Scopelus	2	*Pleuronectidorum*	1
Macrurus	2	*Serranus*	3
Physiculus	1	*Parapercis*	1
Raniceps	1	*Elops*	1
Merluccius	1	*Percidarum*	2
Gadus	1	*Sparidarum*	2
Ophidium	1	*Dentex*	1
Ophidiidarum	1	*Citharus*	1
Trachinus	1	Inc. sedis	1
Fierasfer	1		—
		Total	22

The incidence of their occurrence is as follows:—

STRATIGRAPHICAL ARRANGEMENT, SHOWING OCCURRENCE OF SPECIES.

Fig.	Waikaia.	Wharekuri.	Clifden.	Target Gully.	Ardgowan.	White Rock River.	Awamoa.	Pukeuri.	Tuhua (N. Island).	Castlecliff (N. Island).
	Lower Miocene or Oligocene.			Miocene.			Upper Miocene.			Upper Pliocene.
	Oamaru Series.								Mokau Series.	Wanganui Series.
1	..	..	..	×	×	×	×	×	×	..
2	..	..	..	×	..	..	..	..	..	..
3	..	..	..	..	..	..	..	×	..	..
4	..	..	..	×	×	..	×	×	..	..
5	..	..	..	..	..	..	..	×	..	..
6	..	..	..	..	..	..	..	×	..	..
7	..	..	..	..	..	..	..	×	..	..
7A	..	..	..	..	..	..	..	×	..	×
8	×	..	×	×	×	..	..	×	..	..
9	..	..	..	..	×	..	..	..	..	..
10	×	..	..	..	..	..	..	..	..	..
11	..	..	..	×	..	..	..	..	..	..
12	..	..	..	..	×	..	×	..	..	..
13	..	..	..	..	×	..	..	×	..	..
14	..	..	..	..	..	..	..	×	..	..
15	..	..	..	..	..	..	..	×	..	..
16	..	..	..	×	..	..	..	×	..	..
17, 21	×	..	×	..	..	..	..	..	..	..
18	×	..	..	..	×	..	..	×	..	..
19	×	..	..	..	..	×	..	..	..	..
20	..	×	..	..	..	..	..	..	..	..
22	..	..	..	..	..	..	..	×	..	..
23	..	..	..	..	..	..	..	×	..	..

Otolithus (Scopelus) sulcatus Bassoli. (Plate 61, fig. 1.)

Dimensions.—5 × 4 mm.

Description.—Shape ovate; outer side flat, inner side slightly convex; rostrum obtuse, slight notch below antirostrum. Dorsal, ventral, and posterior rims rounded. Sulcus wide and straight; ostium longer than cauda.

Occurrence.—Tuhua, North Island, 1 example; Pukeuri, 7; Awamoa, 9; White Rock River, 1; Ardgowan, 3; Target Gully, 1. Received from Geological Survey of New Zealand and Mr. H. J. Finlay.

Observations.—This species was described by Bassoli in 1906 as *Otolithus (Berycidarum) sulcatus*, following a similar error by Prochazka in 1893 with regard to *O. (Scopelus) pulcher*. Priem pointed out the misdescription in 1911 (4), the sulcus being distinctly scopeloid and in no way resembling that of the Berycidae. *O. (Scopelus) pulcher* has a more prominent rostrum and a more distinct notch than the species now described, which agrees with *O. (Scopelus) sulcatus* described by Bassoli (1) from the Pliocene of Monte Gibio, near Modena, Italy.

Age.—Tertiary (Miocene): Oamaru series.

Otolithus (Scopelus) circularis n. sp. (Plate 61, fig. 2.)

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

Description.—Circular; outer side domed with radiating lines, inner side flat; notch in ostium; lower line of sulcus with angle between ostium and cauda.

Occurrence.—A single example from Target Gully, received from Mr. H. J. Findlay (type specimen, coll. H. J. Finlay.)

Observations.—This differs in outline and in shape of sulcus from preceding species, also in having radiating furrows on outer side. Priem described in 1911 (4, p. 39) a circular otolith with a distinctly scopeloid sulcus as *O. (Solea) cottreaui* from the Miocene of France, but this had a straighter sulcus than the species now described, which has an outer side unlike any otolith of the Soleidae.

This is without doubt a new species, which I have named *Otolithus (Scopelus) circularis.*

Age.—Tertiary (Miocene): Oamaru series.

Otolithus (Macrurus) gracilis Schubert. (Plate 61, fig. 3.)

Dimensions.—3×3 mm.

Description.—Shape roughly circular; outer side with radiations and umbo in centre, inner side flat with radiating ribs above and below sulcus. A deep semicircular depression above sulcus; no rostrum or antirostrum; slight notch above ostium; cauda narrow and depressed.

Occurrence.—A single example from Pukeuri, received from Geological Survey of New Zealand.

Observations.—This species was described by Schubert in 1905 (9, p. 513) from the Tertiaries of Austria-Hungary, and by Bassoli in 1906 (1) from the Pliocene of Monte Gibio, near Modena, Italy.

Age.—Tertiary (Miocene): Oamaru series.

Otolithus (Macrurus) toulai Schubert. (Plate 61, fig. 4.)

Dimensions.—$7 \times 5\frac{1}{2}$ mm.

Description.—Shape triangular; outer side with longitudinal eminence with radiating furrows extending to rim, forming a serrated edge; inner side convex, smooth. Sulcus extends the length of otolith but does not cut rim. Ostium constricted; cauda narrow with upturned termination.

Occurrence.—Pukeuri, 8 examples; Awamoa, 1; Ardgowan, 2; Target Gully, 2 Received from Geological Survey of New Zealand and Mr. H. J. Finlay.

Observations.—Described by Schubert from the Tertiaries of Austria-Hungary in 1905, and by Bassoli in 1906 from the Pliocene of Monte Gibio, near Modena, Italy. The example figured is a mature specimen, and rather more extended and pointed than the younger examples, which resemble very closely those portrayed by Bassoli, the converging furrows forming a heart-shaped form on the antero-dorsal rim.

Age.—Tertiary (Miocene): Oamaru series.

Otolithus (Physiculus) bicaudatus n. sp. (Plate 61, fig. 5.)

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

Description.—Shape angular; outer side umbonated and furrowed, inner side flat with depression on dorsal part. There is a prominent dorsal

6

4

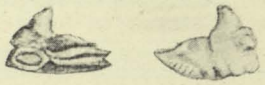
1

7a

9

2

3



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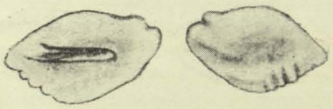

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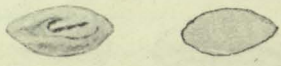

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FIG. 1.—*Otolithus (Scopelus) sulcatus* Bassoli. × 4.
FIG. 2.—*Otolithus (Scopelus) circularis* n. sp. × 4.
FIG. 3.—*Otolithus (Macrurus) gracilis* Schubert. × 3½.
FIG. 4.—*Otolithus (Macrurus) toulai* Schubert. × 2.
FIG. 5.—*Otolithus (Physiculus) bicaudatus* n. sp. × 3.
FIG. 6.—*Otolithus (Raniceps) planus* Koken var. *novae-zeelandiae*. × 4.
FIG. 7.—*Otolithus (Merluccius) pukeuriensis* n. sp. × 3.
FIG. 7*a*.—*Otolithus (Gadus) elegans* var. *sculpta* Koken. × 3.
FIG. 8.—*Otolithus (Ophidium) pantanelli* Bassoli and Schubert. × 3.
FIG. 9.—*Otolithus (Trachinus) mutabilis* Koken. × 5.
FIG. 10.—*Otolithus (Fierasfer) nuntius* Koken. × 4.
FIG. 11.—*Otolithus (Ophidiidarum) elongatus* n. sp. × 4.

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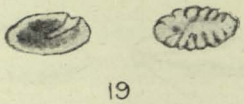

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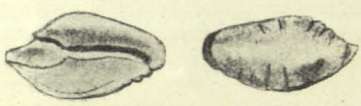

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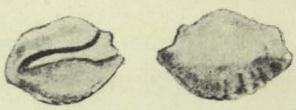

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FIG. 12.—*Otolithus (Pleuronectidarum) acuminatus* Koken. × 4.
FIG. 13.—*Otolithus (Serranus) noetlingi* Koken. × 4.
FIG. 14.—*Otolithus (Elops) miocaenicus* n. sp. × 4.
FIG. 15.—*Otolithus (Percidarum) rectus* Priem. × 3.
FIG. 16.—*Otolithus (Sparidarum) elongatus* Priem. × 4.
FIGS. 17, 21.—*Otolithus (Sparidarum) gregarius* Koken. × 4.
FIG. 18.—*Otolithus (Dentex)* aff. *subnobilis* Schubert. × 4.
FIG. 19.—*Otolithus* (inc. sedis) *umbonatus* Koken. × 5.
FIG. 20.—*Otolithus (Parapercis) finlayi* n. sp. × 6.
FIG. 22.—*Otolithus (Parcidarum) cottreaui* Priem. × 3.
FIG. 23.—*Otolithus (Citharus) latisulcatus* n. sp. × 5.

process anteriorly, with a backward inclination; frontal rim curved with two indentations, ventral rim curved. Sulcus consists of an oval ostium with colliculum, and a duplicated cauda.

Occurrence.—Three examples from Pukeuri, received from Geological Survey of New Zealand. (Type specimen, coll. Geol. Surv. N.Z.)

Observations.—This fossil otolith resembles in a remarkable way the otolith of the living New Zealand species *Physiculus bacchus*. In no other species that has passed through my hands is a double cauda to be seen. The two grooves are equally developed, and both open on the posterior rim, rear of otolith being identical in living and fossil species. Anteriorly they are somewhat different, the oval ostium not being discernible in *Physiculus bacchus* in specimens in my collection, but with further material this may be more apparent. Also, the otolith of living species has an anterior projection which is absent in fossil. In both there is a dorsal horn-like projection, inclined forward in *Physiculus bacchus*, but with a backward inclination in the species now described. The resemblance is unmistakable, and I have therefore called this species *Otolithus (Physiculus) bicaudatus*.

Age.—Tertiary (Miocene): Oamaru series.

Otolithus (Raniceps) planus Koken n. var. **novae-zeelandiae.** (Plate 61, fig. 6.)

Dimensions.—4 × 3 mm.

Description.—Shape ovate; outer side with radiating furrows, inner side flat; serrated above and below. Sulcus extends across otolith; ostium wide and open; cauda narrow with two constrictions.

Occurrence.—A single example from Pukeuri, received from Geological Survey of New Zealand. (Type specimen, coll. Geol. Surv. N.Z.)

Observations.—Outer side almost exactly as in *O. (Raniceps) planus* Koken (3, pl. 4) from the Upper Oligocene of Sternberger Gestein; inner side corresponding also with the exception of ostium, which in *O. (Raniceps) planus* is narrow and closed up in front, while in variety now described ostium is wide, and open in front. I have therefore called this *Otolithus (Raniceps) planus* Koken var. *novae-zeelandiae*.

Age.—Tertiary (Miocene): Oamaru series.

Otolithus (Merluccius) pukeuriensis n. sp. (Plate 61, fig. 7.)

Dimensions.—7 × 3½ mm.

Description.—Shape long-ovate; outer side concave, inner side convex; serrations on edges. Ostium and cauda equal; constriction in middle of sulcus.

Occurrence.—Single example from Pukeuri, received from Mr. H. J. Finlay. (Type specimen, coll. H. J. Finlay.)

Observations.—The species described differs from *Otolithus (Merluccius) obtusus* Koken (3, pl. 11) in contour, in concavity of outer side, and also has angle on frontal rim higher. The cauda also approaches nearer posterior rim than in *obtusus*. The front of otolith slopes as in many of the living Gadidae, but in *Merluccius vulgaris* is more rounded, with angle lower. The sulcus is unmistakably that of *Merluccius*, and I have therefore referred this example to a new species *Otolithus (Merluccius) pukeuriensis*.

Age.—Tertiary (Miocene): Oamaru series.

Otolithus (Gadus) elegans Koken var. **scupita.** (Plate 61, fig. 7*a*.)

Dimensions.—5½ × 3 mm.

Description.—Shape ovate; outer side convex with median ridge and umbo, rim serrated; inner side convex, plain with serrations on edge. Sulcus straight, traverses otolith but does not cut the front or rear edges.

Occurrence.—Single example from Pukeuri, received from Mr. H. J. Finlay.

Observations.—Described by Koken (3, pl. 4) from the Oligocene of Sternberger Gestein.

Age.—Tertiary (Miocene): Oamaru series.

Otolithus (Ophidium) pantanelli Bassoli and Schubert. (Plate 61, fig. 8.)

Dimensions.—6 × 4 mm.

Description.—Shape ovate; outer side convex, smooth with serrations on anterior ventral rim; inner side convex, smooth. Dorsal rim rounded, with fold on posterior angle; ventral rim deep with serrations below the ostium. Sulcus straight; cauda terminates some distance from posterior rim.

Occurrence.—Castlecliff, 1 example; Pukeuri, 4; Ardgowan, 2; Target Gully, 1; Clifden, 1; Waikaia, 5. The Pukeuri specimens were received from Geological Survey of New Zealand, and the others from Mr. H. J. Finlay. (Example figured, coll. H. J. Finlay.)

Observations.—This species was described by Bassoli in 1906 (1, p. 43) from the Pliocene of Monte Gibio and the Miocene of Pantano, Italy. It is very distinctive in shape and in the formation of the sulcus, and appears to range from the Upper Pliocene of Castlecliff, North Island, down to the Oligocene or Miocene of Waikaia, where it is well represented, persisting throughout those Tertiary formations of New Zealand furnishing the material submitted to me.

Age.—Tertiary (Pliocene and Miocene): Oamaru and Wanganui series.

Otolithus (Trachinus) mutabilis Koken. (Plate 61, fig. 9.)

Dimensions.—4 × 2½ mm.

Description.—Shape ovate; outer side concave, inner side convex, front pointed; no rostrum or antirostrum. Sulcus straight; cauda inclined slightly upward.

Occurrence.—One example from Pukeuri, received from Geological Survey of New Zealand; one from Ardgowan, from Mr. H. J. Finlay.

Observations.—The shape of otolith and upward tilt of cauda indicate that this example should be referred to the Trachinidae. The sulcus differs slightly from *Otolithus (Trachinus) mutabilis* described by Koken (2) in 1884 from the Oligocene of Germany and the Miocene of Voeslau, Austria, but the general resemblance is to be seen. Priem (8, p. 274) in 1914 described specimens of this species from the Burdigalien of Martillac, in south-west France, and in one of these the sulcus is nearer that of example now described. I have therefore referred this example to the species described by Koken as *Otolithus (Trachinus) mutabilis.*

Age.—Tertiary (Miocene): Oamaru series.

Otolithus (Fierasfer) nuntius Koken. (Plate 61, fig. 10.)

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

Description.—Shape ovate; outer side convex, umbonated; inner side flat. Sulcus oval in centre of otolith occupied by colliculum.

Occurrence.—Two examples from Waikaia, received from Mr. H. J. Finlay.

Observations.—This species, which compares well with otoliths of the living *Fierasfar umbratilis*, has been described by Koken (3) from the Oligocene of Soellingen as *Otolithus (Fierasfer) nuntius* Koken.

Age.—Tertiary (Oligocene or Miocene); Oamaru series.

Otolithus (Ophidiidarum) elongatus n. sp. (Plate 61, fig. 11.)

Dimensions.—3×2 mm.

Description.—Shape ovate with pointed ends, both sides convex. Sulcus short, oblique.

Occurrence.—Single example from Target Gully, received from Mr. H. J. Finlay. (Type specimen, coll. H. J. Finlay.)

Observations.—This species is very similar in outline to that described by Priem (7, p. 157) as *Otolithus (Ophidiidarum)* aff. *kokeni* from the Lutetien of Le Bois-Gouët, Brittany, but the sulcus is different, conforming to that of *Otolithus (Ophidiidarum) pantenelli* Bassoli and Schubert, seen in Plate 61, fig. 8. I have therefore called this *Otolithus (Ophidiidarum) elongatus*.

Age.—Tertiary (Miocene): Oamaru series.

Otolithus (Pleuronectidarum) acuminatus Koken. (Plate 62, fig. 12.)

Dimensions.—3×1 mm.

Descriptions.—Shape long with pointed ends, biconvex. Sulcus small, oval.

Occurrence.—Awamoa and Ardgowan, four examples, received from Mr. H. J. Finlay.

Observations.—This species was described by Koken (3) from the middle Oligocene of Waldboeckelheim, and also by Bassoli (1) from the Pliocene of Monte Gibio, Italy.

Age.—Tertiary (Miocene): Oamaru series.

Otolithus (Serranus) noetlingi Koken. (Plate 62, fig. 13.)

Dimensions.—5×3 mm.

Description.—Shape ovate; upper rim sloping to rear; outer side concave, inner side convex; ventral rim carinate. Rostrum blunt, antirostrum slight. Ostium wide; cauda longer than ostium, straight, with slight curve downwards at terminations which does not reach posterior rim of otolith.

Occurrence.—Pukeuri and Ardgowan, numerous examples, received from Geological Survey of New Zealand and Mr. H. J. Finlay.

Observations.—The general form and shape of the sulcus are as in the specimens described by Koken (3) from the Upper Oligocene of Sternberger Gestein. Similar otoliths are described by Priem (8) from the Burdigalien of Leognau, France, and referred by him to the above-named species.

Age.—Tertiary (Miocene): Oamaru series.

Otolithus (Elops) miocaenicus n. sp. (Plate 62, fig. 14.)

Dimensions.—4 × 2½ mm.

Description.—Shape ovate; outer side concave, inner side convex; crest of dorsal rim slightly behind middle of otolith; ventral rim carinate with forward projection. Rostrum large, no antirostrum. Sulcus straight, oblique, terminating close to ventral rim but well away from rear of otolith.

Occurrence.—Single example from Pukeuri, received from Geological Survey of New Zealand. (Type specimen, coll. Geol. Surv. N.Z.)

Observations.—This otolith is reproduced in those of the living species *Elops hawaiensis*, the specimens with which I have compared it coming from the Dutch East Indies. It has not been described before, and I have named it *Otolithus (Elops) miocaenicus*.

Age.—Tertiary (Miocene): Oamaru series.

Otolithus (Percidarum) rectus Priem. (Plate 62, fig. 15.)

Dimensions.—6 × 4 mm.

Description.—Shape ovate; outer side concave, showing rings of growth; inner side convex. Sulcus long, with downward curve terminating on posterior rim of otolith. Ostium very small; cauda long.

Occurrence.—Single example from Pukeuri, received from Geological Survey of New Zealand.

Observations.—In looking at the outer side of this otolith one is much inclined to place it among those of the flat fishes: the nearly flat oval form showing the annual rings is the same as in the otoliths of the Pleuronectidae. The sulcus, however, is distinctly of the percoid type; and, although the flat fishes are probably derived from the Percoids, the only species with a similar sulcus is *psettodes*, the other members of the order Heterosomata having a very minute cauda compared with the ostium, while in the species described the cauda is by far the greater. Priem (7, p. 156) has described a similar form of otolith from the Lutetien of Le Bois-Gouët, in Brittany, as *Otolithus (Percidarum) rectus*, and in referring the present example to this species it is worth noting that it apparently forms a link between the otoliths of the Percoids and those of the Heterosomata.

Age.—Tertiary (Miocene): Oamaru series.

Otolithus (Sparidarum) elongatus Priem. (Plate 62, fig. 16.)

Dimensions.—4 × 3 mm.

Description.—Shape elliptical; outer side concave, with radiations on lower part; inner side convex; rostrum blunt, no antirostrum. Ostium wide; cauda curving down and terminating some distance from posterior rim.

Occurrence.—Two examples, from Pukeuri and Target Gully, received from Geological Survey of New Zealand and Mr. H. J. Finlay.

Observations.—This species is longer in proportion to the height than *Otolithus (Sparidarum) gregarius;* otherwise the general appearance is somewhat similar. Described by Priem (6) in 1913 from the Lutetien of Le Bois-Gouët, France.

Age.—Tertiary (Miocene): Oamaru series.

Otolithus (Sparidarum) gregarius Koken. (Plate 62, figs. 17, 21.)

Dimensions.—4½ × 4 mm.

Description.—Shape roughly circular; outer side concave with umbo, inner side convex; dorsal rim rounded posteriorly, ventral rim carinate. Rostrum blunt, no antirostrum. Ostium wide; cauda narrow and curved downward.

Occurrence.—Three examples from Waikaia and Clifden, received from Mr. H. J. Finlay.

Observations.—Described by Koken (3) from the Upper Oligocene of Sternberger Gestein; also by Priem (8) from the Burdigalien of south-west France.

Age.—Tertiary (Oligocene or Lower Miocene): Oamaru series.

Otolithus (Dentex) aff. subnobilis Schubert. (Plate 62, fig. 18.)

Dimensions.—3¼ × 2½ mm.

Description.—Shape elliptical; outer side concave with radiating furrows to ventral rim, and oblique groove on anterior part of dorsal rim; inner side flat. Sulcus straight, ostium wide, upward inclination. Cauda wide with open termination; does not extend to posterior rim.

Occurrence.—Three examples, from Waikaia, Ardgowan, and Pukeuri, received from Geological Survey of New Zealand and Mr. H. J. Finlay.

Observations.—Described by Schubert in 1906 (10) from the Tertiaries of Austria-Hungary, and by Priem (8 p. 264) in 1914 from the Burdigalien of Leognau, south-west France.

Age.—Tertiary (Miocene): Oamaru series.

Otolithus (inc. sedis) umbonatus Koken. (Plate 62, fig. 19.)

Dimensions.—2 × 1 mm.

Description.—Shape ovate, biconvex; outer side umbonated. Sulcus narrow, oblique with ostium on dorsal rim.

Occurrence.—Two examples, from Waikaia and White Rock River, received from Mr. H. J. Finlay.

Observations.—Described by Koken (2) from the Oligocene of Lattorf, Söllingen, Antwerp, and other places.

Age.—Tertiary (Miocene): Oamaru series.

Otolithus (Parapercis) finlayi n. sp. (Plate 62, fig. 20.)

Dimensions.—2 × 1 mm.

Description.—Outer side convex, umbonated; inner side flat; dorsal rim serrated, and sloping equally to front and rear of otolith; ventral rim crescentic. Sulcus oblique; ostium and cauda of equal length. Cauda terminates some distance from rear of otolith.

Occurrence.—Single example from Wharekuri, received from Mr. H. J. Finlay. (Type specimen, coll. H. J. Finlay.)

Observations.—This solitary and minute example is of a distinctive percoid type. I find that it most resembles the otoliths of the so-called "blue cod" of New Zealand (*Parapercis colias*), and have therefore named it *Otolithus (Parapercis) finlayi*, after Mr. H. J. Finlay, to whom I am indebted for sending the specimen.

Age.—Tertiary (Oligocene): Oamaru series.

Otolithus (Percidarum) cottreaui Priem. (Plate 62, fig. 22.)

Dimensions.—5 × 4 mm.

Description.—Shape circular; outer side flat, inner side convex; indentation in posterior rim. Sulcus broad; ostium depressed, wide. Cauda wide, curved downward, termination close to posterior rim.

Occurrence.—Single example from Pukeuri, received from Mr. H. J. Finlay.

Observations.—This was described by Priem in 1912 (5, p. 247) from the Eocene of Le Bois-Gouët, of south-west France. The example from Pukeuri differs in having the notch on posterior rim, but otherwise the resemblance is sufficient for identification.

Age.—Tertiary (Miocene): Oamaru series.

Otolithus (Citharus) latisulcatus n. sp. (Plate 62, fig. 23.)

Dimensions.—2½ × 2 mm.

Description.—Shape ovate; outer side convex, inner side slightly convex; dorsal and ventral rims rounded; angle between dorsal and posterior rim. Rostrum pointed, no antirostrum or notch. Sulcus very wide; cauda opening widely on posterior rim.

Occurrence.—A single example from Pukeuri, received from Mr. H. J. Finlay. (Type specimen, coll. H. J. Finlay.)

Observations.—On comparing this specimen with the otoliths of the living *Citharus linguatula* the resemblance is at once apparent. Bassoli (1) describes a fossil *Citharus* otolith from the Pliocene of Monte Gibio—*Otolithus (Citharus) schuberti;* but in this species the cauda is narrower and does not widen out on the posterior rim as in the example now described. The outline also is different. We have here a new species, which I have named *Otolithus (Citharus) latisulcatus.*

Age.—Tertiary (Miocene): Awamoa series.

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