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or where two systems of folds interfere¹⁾ exceptions to the above mentioned rules and complicated cases may be expected. The deep sea chart of the Siboga shows good examples of this fact.

Zoology. — “*On the Freshwater Fishes of Timor and Babber.*” By
MAX WEBER and L. F. DE BEAUFORT.

The Timor Expedition, under leadership of Prof. G. A. F. MOLENGRAAFF, returned to Holland with extraordinarily rich mineralogical, palaeontological and geological collections and its leader has already communicated some important preliminary results, which are of great importance, not only to our knowledge of Timor, but also to the geological history of the whole indo australian archipelago. As they throw new light on the youngest phases in the development of the archipelago, they are of special importance to the zoogeographer too.

Therefore it is a memorable fact, that Prof. MOLENGRAAFF consented to our request to make a collection of freshwater fishes, when time and circumstances permitted, as thus important light is thrown on at any rate the younger phases of the evolution of the indo-australian archipelago.

We are glad to seize this opportunity to thank him as well as his collaborator Mr. F. A. H. WECKHERLIN DE MAREZ OYENS for the collection of well preserved specimens of fish, brought together by the lastnamed in different rivers of Timor and the island of Babber.

As far as we know, Babber was — ichthyologically — a terra incognita. The following fishes were collected by Mr. WECKHERLIN DE MAREZ OYENS in the rivers (Jer), which are mentioned next to the name of the fishes.

Anguilla mauritiana BENN. Jer Lawi, 7 Km. above mouth. Jer Toilila near Tepa, 500 M. above mouth.

Caranx carangus BL. Jer Lawi, 7 Km. above mouth.

Gymnapistus niger C. V. Jer Lawi, 7 Km. above mouth.

Eleotris gyrinoides BLKR. Jer Toilila near Tepa, 500 M. above mouth. Jer Lawi, 7 Km. above mouth.

¹⁾ The East-Indian archipelago is situated in the area of junction of two systems of folding of the earth's crust, the alpine and circumpacific system, vide E. HAUG. Les géosynclinaux et les aires continentales. Bull. de la Soc. Géol. de France. 1900. 3. Sér. Vol. 28 p. 635. Whereas E. HAUG refers in this area to an “embranchement” of the two systems, SARASIN goes further and speaks of an actual conflict: “Ich habe noch immer den Eindruck, dasz es sich im malayischen Archipel um einen Konflikt zwischen den Kettensystemen der Tethys und denen der pazifischen Umrahmung handle”. P. SARASIN. Zur Tektonik von Celebes. Monatsberichte der deutschen Geol. Ges. 1912. p. 215.

Eleotris (Culius) fusca Bl. Jer Toilila near Tapa, 500 M. above mouth.
Eleotris (Belobranchnus) belobranchnus C. V. Jer Lawi, 7 Km. above mouth.

Gobius spec. Jer Toilila near Tapa 500 M. above mouth.
Sicyopterus micrurus BLKR. Jer Lawi, 7 Km. above mouth. Jer Toilila near Tapa, 500 M. above mouth.

Sicyopterus cynocephalus C. V. Jer Lawi 7 Km. above mouth.

On the fishfauna of Timor BLEEKER¹⁾ wrote 7 papers between the years 1852 and 1863. There is not much to be learned from them for our purpose, however. Any exact account of the localities where they were taken, is lacking. Doubtless by far the greater part was captured in the littoral waters of Kupang and Atapupu. The following 7 only are specially recorded from a river near Deli:

Megalops indicus C. V. = *Megalops cyprinoides* BROUSS.

Anguilla australis RICHARDS.

Atherina lacunosa FORST. = *Atherina Forskali* RÜPP.

Mugil brachysoma C. V. = *Mugil sundanensis* BLKR.

Acanthurus matoides C. V.

Caranx forsteri C. V.

Eleotris Hoedti BLKR.

The locality and the nature of the fishes make it probable, that they were caught not far from the mouth of the river.

In 1894 the first named of us²⁾ published a more extensive list of the fishes of Timor, chiefly due to Prof. A. WICHMANN, who was kind enough, during his stay in Timor in the spring of 1889, to collect the following fishes in the river Koinino and other small streamlets in the neighbourhood of Kupang, as well as in the river near Atapupu.

Mugil (Bleekeri GTHR.?) river Koinino.

Kuhlia marginata C. V. river Koinino.

Ambassis buroensis BLKR. river near Kupang.

Ambassis batjanensis BLKR. river Koinino.

Therapon jarbua FORSK. river near Kupang.

Caranx hippos L. river near Kupang.

Eleotris hoedti BLKR. river near Atapupu.

Eleotris fusca Bl. SCHN. river near Atapupu.

Gobius celebius C. V. rivers near Kupang.

Gobius melanocephalus BLKR. river Koinino.

Sicyopterus Wichmanni M. WEB. near Kupang.

¹⁾ Nat. Tijdschr. Ned. Indië III, 1852. p. 159—174. Ibid. VI, 1854. p. 203—214. Ibid. XIII, 1857. p. 387—390. Ibid. XVII, 1858 p. 129—140. Ibid. XX, 1859. p. 442—445. Ibid. XXII, 1861, p. 247—261. Ned. Tijdschr. Dierk. I, 1863, p. 262—276.

²⁾ MAX WEBER. Zool. Ergebnisse einer Reise in Niederl-Indiën. III, 1894. p. 433.

Then Dr. H. TEN KATE collected a few freshwater fishes, which have been published by Dr. C. L. REUVENS ¹⁾. These are:

Anguilla bengalensis (Gray) Gthr. = *Anguilla mauritiana* Benn. from a lake near Baun.

Anabas scandens Dald. near Amarassi and from lake Nefko near Oikaliti.

Lastly Mr. H. A. LORENTZ was kind enough to collect in August 1909, when passing Kupang on his way to New Guinea, the following fishes from the river Koinino:

Eleotris (~~*Belobranchus*~~) *belobranchus* C. V.

Gobius celebius C. V.

Gobius melanocephalus BLKR.

The great value of the fishmaterial collected by the Timor expedition lies in the fact, that it comes from the interior of Timor, far away from the sea, and from altitudes varying between 200 and 900 M. It gives a picture of the fishfauna in the upper course of the rivers, while the previously known material came from the lower course of the rivers. The collection consists of the species mentioned below, from the following localities:

1. Mota Berluli, District Djenilu, Belu, 1 Km. above mouth.
2. Noil Enfut (= Noil Mauden) between Wikmurak and Oi Lollo, District Insana, area of the river Noil Benain, about 200 M. above sea.
3. Area of the river Mota Talau, from streamlet without name near camp Naitimu, Belu, about 250 M. above sea.
4. Noil Bidjeli (= Noil Noni), near camp Bidjeli, upper area of the river of Noil Benain, District Mollo, about 350 M. above sea.
5. Noil Aplaal (= Noil Besi), near camp Aplaal, District Miomaffo, about 500 M. above sea.
6. Noil Besi near path from Fatu Seinaan to Bonleo, about 900 M. above sea.
7. River Bele, near the source of the river Noil Tuke, District Amanzebang, about 700 M. above sea.

Anguilla mauritiana BENN., Noil Besi, River Bele.

Anguilla celebesensis KAUP, River Bele.

Aplocheilichthys celebensis M. WEB., Area of the river Mota Talau.

Mugil spec. Mota Berluli.

Aeschrichthys Goldiei MACLEAY, Noil Bidjeli.

Kuhlia marginata C. V., Noil Bidjeli, Noil Aplaal.

¹⁾ C. L. REUVENS. Fresh and brackish water fishes from Sumba, Flores, Groot-Bastaard, Timor, Samaoe and Rotti. Notes Leyden Museum XVI 1895, p. 154.

	In Timor.		Also recorded from sea?	Distribution outside Timor.
	Mouth of rivers (brackish)	Fresh-water		
<i>Megalops cyprinoides</i> Brouss.	+	-	yes	Indopacific.
<i>Anguilla celebesensis</i> Kaup	-	+	} Katadrom fishes.	Eastern part of indo-australian Archipelago to Westpacific islands.
<i>Anguilla mauritiana</i> Benn.	-	+		From East Africa to Westpacific islands.
<i>Anguilla australis</i> Richards.	+	-		From India to Australia and New-Zeeland.
<i>Aplocheilus celebensis</i> M. Web.	-	+	no	Celebes.
<i>Atherina Forskali</i> Rüpp.	+	-	yes	From Red Sea to Westpacific islands.
<i>Mugil spec. juv.</i>	-	+	-	-
<i>Mugil (Bleekeri Gthr.?)</i>	-	+	brackish water	Banka, Aru-islands.
<i>Mugil sundanensis</i> Bleeker	+	-	yes	Indo-australian Archipelago.
<i>Aeschrichthys Goldiei</i> Macleay	-	+	no	South New Guinea, Philippines.
<i>Anabas scandens</i> Dald.	-	+	no	From Ceylon through indo-australian Archipel. to Halmahera and Batjan?
<i>Kuhlia rupestris</i> C.V.	+	+	no	From East Africa to Westpacific islands.
<i>Kuhlia marginata</i> C.V.	-	+	yes	Indo-australian Archipel. to Westpacific islands.
<i>Toxotes jaculator</i> Pall.	+	-	no	Indo-australian Archipel.
<i>Ambassis buroensis</i> Bleeker	-	+	yes	Indo-australian Archipel.
<i>Ambassis batjanensis</i> Bleeker	-	+	yes	Indo-australian Archipel.
<i>Lutjanus fuscescens</i> C.V.	-	+	brackish water	Indo-australian Archipelago to Westpacific islands and China.
<i>Therapon jarbua</i> Forsk.	-	+	yes	Indo-pacific.
<i>Therapon cancellatus</i> C.V.	-	+	yes	Indo-australian Archipel.
<i>Acanthurus matoides</i> C.V.	+	-	yes	Indo-pacific.
<i>Caranx forsteri</i> C.V.	+	-	yes	Indo-pacific.
<i>Eleotris Hoedti</i> Bleeker	+	+	brackish water	Brackish and freshwater from India to Westpacific.
<i>Eleotris belobranchus</i> C.V.	-	+	brackish water	Brackish and freshwater of Indo-australian Archip.
<i>Eleotris fusca</i> Bl. Schn.	-	+	brackish water	Brackish and freshwater of Indopacific.
<i>Eleotris gyrinoides</i> Bleeker	-	+	brackish water	Brackish and freshwater of Sumatra and Celebes.
<i>Gobius celebius</i> C.V.	-	+	yes	Seas and rivers of Indo-australian archipelago.
<i>Gobius melanocephalus</i> Bleeker	-	+	yes	Seas and rivers of India and Indo-australian Archipelago.
<i>Sicyopterus Wichmanni</i> M. Web.	-	+	no	Flores.
<i>Sicyopterus cynocephalus</i> C.V.	-	+	no	Indo-Australian Archipel.

Kuhlia rupestris LACÉP., Noil Aplaal.

Lutjanus fuscescens C. V., Mota Berluli.

Therapon cancellatus C. V., Noil Aplaal.

Eleotris (Ophiocara) Hoedti BLKR., Mota Berluli.

Eleotris gyrinoides BLKR., Mota Berluli, Noil Enfut.

Gobius celebius C. V., Mota Berluli.

Gobius melanocephalus BLKR., Mota Berluli, Noil Enfut.

Sicyopterus cynocephalus C. V. Noil Enfut, Noil Besi.

The zoogeographical importance of all the species hitherto known from the freshwater of Timor will be more pronounced in a table in which is mentioned at the same time whether the species are known to inhabit the sea, in which case it is proved that salt water does not constitute a barrier against their distribution. Furthermore the distribution of the mentioned species is noted in our table.

From this table the following may be deduced:

1. Contrary to expectation Timor misses every australian or papuan element in its freshwater fishfauna. We mean by that the *Melanotaeniidae*, which are only known from Australia, New Guinea, Waigeu and the Aru islands and which are still represented on lastnamed islands by *Pseudomugil* and *Rhombattractus*, and further such forms as *Neosilurus*, *Eleotris aruensis* M. WEB., *E. Mertoni* M. WEB., *E. mogurnda* RICHARDS, which are also found on the Aru islands.

2. On the other hand a few fishes: *Anabas scandens* DALD. and *Aplocheilichthys celebensis* M. WEB., occurring in the freshwater fauna of Timor, are forms which are entirely lacking in the freshwater of the australian or papuan region.

3. The most striking fact however is, that 15 of the 28 enumerated species occur as well in the sea, temporarily (*Anguillidae*) or permanently, and 6 of them also in brackish water. The 7 remaining are hitherto only known from freshwater. From these 7 *Aeschrichthys Goldiei* MACL., *Kuhlia rupestris* C. V., *Sicyopterus Wichmanni* M. WEB. and *Sicyopterus cynocephalus* C. V. are closely related to forms for which salt water, or at least brackish water does not form a hindrance in their dispersion.

In other words the freshwater fishfauna of Timor has a marine character, it is almost totally composed of immigrants from the sea.

This very remarkable phenomenon can be explained by what the geological history of Timor teaches, as conceived by MOLENGRAAFF. To us the following is of importance.

Timor was covered by sea during a very great part of the pleistocene. The high mountains however (Mutis, Lakaan etc.) projected above the sea. They must have been comparatively high at that time

too, as the water, running in torrents from their sides, carried down much gravel. It was evidently a landformation not very apt to lodge a freshwater fauna of any importance. It is difficult to ascertain whether elements of this fauna still survive in the present fauna. This might possibly be the case with *Aplocheilus celebensis* M. WEB. and *Anabas scandens* DALD., which form a special element in the present fauna. One of these, *Aplocheilus* belongs to the family *Poecilidae*, several genera of which are known from the early tertiary; and *Anabas scandens* has a very wide range of distribution, from the continent of Asia to the eastern part of the indo australian archipelago.

The recent fishfauna only came to full development when Timor was raised to its present level in post pleistocene times. This very young land developed a system of rivers, which could only be populated by such fishes, as are not hindered by salt water in their distribution. Timor, when rising, was surrounded by sea. The ichthyological material tends to prove that this was originally a shallow sea, possibly surrounding other greater or smaller islands in the neighbourhood, as, for several elements of the freshwaterfauna of Timor, a deep sea with a high salinity would form an unsurmountable barrier. Such a sea could only have been formed after the immigration in the freshwater was accomplished for the greater part.

We are of opinion that this is in accordance with the views of MOLENGRAAFF, who thinks that the formation of the deep seas along the north and south coast of Timor took place in connection with the final upheaval of the island, and that this has been the latest event.

Physics. — “*On the Deduction of the Equation of State from BOLTZMANN’s Entropy Principle.*” By Dr. W. H. KEESOM. Supplement No. 24a to the Communications from the Physical Laboratory at Leiden. (Communicated by Prof. H. KAMERLINGH ONNES).

(Communicated in the meeting of April 26, 1912).

§ 1. *Introduction.* Since the two great advances made by VAN DER WAALS in deducing his equation and in developing the theory of corresponding states therefrom, the theoretical investigation of the equation of state for a single component substance has been developed in various directions, particularly by VAN DER WAALS himself; these developments have cleared up and enriched our knowledge of various circumstances which influence the equation of state, and which had