New data on freshwater fishes of New Caledonia

Philippe **Keith**, Clara **Lord**, Laura **Taillebois** & Pierre **Feutry**

Muséum national d'Histoire naturelle, UMR BOREA 7208 MNHN-CNRS-UPMC-IRD, DMPA, CP026, 43 rue Cuvier, 75231 Paris Cedex 05, France
keith@mnhn.fr

ABSTRACT

Since 1861, freshwater fishes have been studied at different periods in New Caledonia. The first list was published in 1915, but the major inventories were done between 1998 and 2003. These inventories allowed the discovery of many new species and the publication, in 2003, of the *Atlas of Freshwater fish and crustaceans of New Caledonia*, which listed 64 freshwater fish species. Between 2004 and 2010, additional specific surveys were conducted by the MNHN and 9 species were added. Among them, 3 were new for science. Gobiidae family represents 30% of the freshwater fishes of New Caledonia. This high percentage is explained by their particular life cycle adapted to insular systems.

RÉSUMÉ

Nouvelles données sur les poissons d'eau douce de Nouvelle-Calédonie.

La faune ichtyologique des eaux douces a été étudiée à diverses reprises et à divers degrés en Nouvelle-Calédonie depuis 1861. La première liste des espèces a été établie en 1915, mais c'est entre 1998 et 2003 qu'ont été entrepris les plus gros efforts d'inventaires. Ceux-ci ont donné naissance à la description de plusieurs espèces nouvelles ainsi qu'à la publication, en 2003, de « *l'Atlas des poissons et crustacés d'eau douce de Nouvelle-Calédonie* », qui comprenait 64 espèces de poissons. De nouveaux inventaires menés entre 2004 et 2010 par le MNHN ont porté le nombre d'espèces à 73. Parmi les 9 espèces signalées en plus par rapport à 2003, 3 sont nouvelles pour la science. Les Gobiidae présentent 30% des espèces de poissons connus dans les eaux douces de Nouvelle-Calédonie. Ce fort pourcentage est expliqué notamment par les traits de vie particuliers de ces espèces et leur adaptation aux systèmes insulaires.

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INTRODUCTION

Fishes have been studied at different periods in New Caledonia. Jouan (1861, 1863, 1877), Castelnau (1873) and Ogilby (1897) were the first to work on them. Jouan cited only marine and brackish fishes. Castelnau (1873) listed 14 species, a few being freshwater species, collected by Mr Adet from Noumea, but there was no location information. Ogilby (1897) gave a list of 6 freshwater species, but it was not until 1915, with the publication of Weber and de Beaufort's paper, that the first list of freshwater fishes of New Caledonia appeared. This list, containing nearly 30 species, was produced with the samples collected on 26 rivers by Sarasin and Roux between 1911 and 1912. Later, Starmülhner (1968) prospected 42 rivers, but only for molluscs and some crustaceans. In 1991, the PEDCAL expedition organised by the Muséum national d'Histoire naturelle (MNHN), prospected 31 rivers (Séret 1997) and increased significantly the number of collected species.

Finally, between 1998 and 2003, the MNHN conducted, with the provincial and territorial authorities, an exhaustive inventory of freshwater fish (CHLOE expeditions). Inventories were undertaken on the major hydrosystems of Grande-Terre and Loyalties Islands and allowed the discovery of many new species (Keith *et al*. 2000; 2002; Watson *et al*. 2001, 2002, 2005; Marquet *et al*. 2003). At the end of these expeditions, a reference book was published: *the Atlas of Freshwater fish and crustaceans of New Caledonia* (Marquet *et al*. 2003). These inventories were completed between 2004 and 2010 during additional specific studies conducted by the MNHN with the Provinces, particularly in Panié Mountain (2004, 2006, 2010) Poindimié area (2006, 2010) and Bélep Islands (2007) (North Province) (Keith *et al.* 2009a), and Yaté area (2007) and Côte oubliée (2009) (South Province). They led to the discovery of new species (Keith *et al.* 2009b; Keith *et al.* 2010) and of species never caught in New Caledonia.

The purpose of this paper is to update the list of the freshwater fish species of New Caledonia, with a particular insight on amphidromous gobies.

MATERIALS AND METHODS

During 2004-2010, nearly 60 rivers, representing 250 stations, were prospected in both North and South Provinces of New Caledonia.

Investigations were undertaken by Punctual Abundance Sampling (PAS); sampling was done using electrical fishing methods at a large number of randomised points in the streams. The position of the points must respect the proportion of the diversity of run-off habitats. The surface prospected at each point corresponds to the anode's electrical field.

For electrical fishing methods, a current generator was used: a portable machine using a battery with an output power of 180 W. It gives rectangular impulses at a fixed frequency of 100 Hz or 400 Hz. The duty cycle is controllable and is of 5 to 25%. It has three voltage outputs: 150, 200 and 300 V.

Electrical fishing is performed wading upstream, that way the water stays clear in front of the fisherman. The method consists in placing a fishing electrode near shelters in which the animals are found; the electrode creates an electrical field, which has an attraction effect within a radius of a one-metre zone under average conditions. When a fish comes within this field, it is stunned; it can then be caught easily with a hand net.

Each species caught was identified and, when preserved, the material was deposited in the collection of the National Museum of Natural History in Paris.

RESULTS

The 2004-2010 expeditions brought new material and nine new recorded species were caught, compared to the Atlas published in 2003 (Marquet *et al.* 2003). Among them, six widespread species are now known to occur also in New Caledonia and three were recently described as new species. Among the nine new records for New Caledonia, five concern the Gobiidae Sicydiinae subfamily (Teleostei) with two new species.

The new occurrences are: among the Gobiidae, *Stiphodon semoni* Weber 1895, found in North Province (Pouebo), with very few specimens; *Smilosicyopus fehlmanni* (Parenti & Maciolek, 1993) caught in North Province in many rivers,

Redigobius balteatus (Herre, 1935) (Dumbéa river); and among the Syngnathidae, *Microphis argulus* (Peters, 1855). Two new introduced species were also caught locally in some swamps and rivers: *Trichopodus trichopterus* (Pallas, 1770) and *Xiphophorus maculatus* (Günther, 1866). The new species described since 2003 are *Smilosicyopus pentecost* (Keith, Lord & Taillebois, 2010) from Bélep and North Province in New Caledonia and Vanuatu, *Stiphodon mele* Keith, Lord & Pouilly, 2009 from New Caledonia and Vanuatu; both are Gobiidae Sicydiinae, and *Bleheratherina pierucciae* Aarn & Ivantsoff, 2009 (Atherinidae), a freshwater species from South Province rivers.

The updated list of freshwater fishes of New Caledonia is given in Table 1.

TABLE 1

List of Freshwater fish species of New Caledonia. * introduced ; Bold new record.

FAMILIES	SPECIES NAMES
Anguillidae	*Anguilla australis* Richardson, 1841 *Anguilla marmorata* Quoy & Gaimard, 1824 *Anguilla megastoma* Kaup, 1856 *Anguilla obscura* Günther, 1872 *Anguilla reinhardtii* Günther, 1872
Moringuidae	*Moringua microchir* Bleeker, 1853
Ophichthyidae	*Lamnostoma kampeni* (Weber & de Beaufort, 1916) *Lamnostoma orientalis* (McClelland, 1844)
Muraenidae	*Gymnothorax polyuranodon* (Bleeker, 1854)
Galaxiidae	*Galaxias neocaledonicus* Weber & de Beaufort, 1913
Cyprinidae	*Carassius auratus* (Linnaeus, 1758) * *Cyprinus carpio* Linnaeus, 1758 *
Poeciliidae	*Poecilia reticulata* Peters, 1859 * *Xiphophorus hellerii* Heckel, 1848 * ***Xiphophorus maculatus* (Günther, 1866) ***
Syngnathidae	*Microphis brachyurus* (Bleeker, 1854) ***Microphis argulus* (Peters, 1855)** *Microphis cruentus* Dawson & Fourmanoir, 1981 *Microphis leiaspis* (Bleeker, 1853) *Microphis retzii* (Bleeker, 1856)
Atherinidae	***Bleheratherina pierucciae* Aarn & Ivantsoff, 2009**
Mugilidae	*Cestraeus oxyrhyncus* Valenciennes, 1836 *Cestraeus plicatilis* Valenciennes, 1836 *Crenimugil crenilabis* (Forsskål, 1775) *Crenimugil heterocheilos* (Bleeker, 1855) *Liza melinoptera* (Valenciennes, 1836) *Chelon planiceps* (Valenciennes, 1836) *Mugil cephalus* Linnaeus, 1758
Ambassidae	*Ambassis miops* Günther, 1872 *Ambassis interrupta* Bleeker, 1853
Kuhliidae	*Kuhlia marginata* (Cuvier, 1829) *Kuhlia munda* (De Vis, 1884) *Kuhlia rupestris* (Lacepède, 1802)
Scatophagidae	*Scatophagus argus* (Linnaeus, 1766)
Centrarchidae	*Micropterus salmoides* (Lacepède, 1802) *
Cichlidae	*Oreochromis mossambicus* (Peters, 1852) * *Sarotherodon occidentalis* (Daget ,1962) *

Belontiidae	*Trichogaster pectoralis* (Regan, 1910) * ***Trichopodus trichopterus* (Pallas, 1770) ***
Microdesmidae	*Parioglossus neocaledonicus* Dingerkus & Séret, 1992
Eleotridae	*Butis amboinensis* (Bleeker, 1853) *Eleotris acanthopoma* Bleeker, 1853 *Eleotris fusca* (Forster, 1801) *Eleotris melanosoma* Bleeker, 1852 *Hypseleotris cyprinoides* (Valenciennes, 1837) *Bunaka gyrinoides* (Bleeker, 1853) *Giuris margaritacea* (Valenciennes, 1837) *Ophieleotris* sp. *Ophiocara porocephala* (Valenciennes, 1837)
Gobiidae	*Awaous guamensis* (Valenciennes, 1837) *Awaous ocellaris* (Broussonet, 1782) *Psammogobius biocellatus* (Valenciennes, 1837) *Glossogobius illimis* Hoese & Allen, 2012 *Lentipes kaaea* Watson, Keith & Marquet, 200 *Mugilogobius notospilus* (Günther, 1877) *Mugilogobius mertoni* (Weber, 1911) *Redigobius balteatus* (Herre, 1935) ***Redigobius bikolanus* (Herre, 1927)** *Schismatogobius fuligimentus* Chen, Séret, Pöllabauer & Shao, 2001 *Sicyopterus lagocephalus* (Pallas, 1770) *Sicyopterus sarasini* Weber & de Beaufort, 1915 *Smilosicyopus chloe* (Watson, Keith & Marquet, 2001) ***Smilosicyopus fehlmanni* (Parenti & Maciolek, 1993)** ***Smilosicyopus pentecost* (Keith, Lord & Taillebois, 2010)** *Sicyopus zosterophorum* (Bleeker, 1856) *Stenogobius yateiensis* Keith, Watson & Marquet, 2002 *Stiphodon atratus* Watson, 1996 ***Stiphodon mele* Keith, Marquet & Pouilly, 2009** *Stiphodon sapphirinus* Watson, Keith & Marquet, 2005 ***Stiphodon semoni* Weber, 1895** *Stiphodon rutilaureus* Watson, 1996
Rhyacichthyidae	*Rhyacichthys guilberti* Dingerkus & Séret, 1992 *Protogobius attiti* Watson & Pöllabauer, 1998

BIODIVERSITY OF FRESHWATER FISH IN NEW CALEDONIA

The updated list of freshwater fishes indexes now 73 species versus 64 in the Atlas published in 2003. Among them, 22 species of freshwater gobies are listed (30%), and among the Gobiidae, the Sicydiinae subfamily was the most diverse with 12 species (16.4%) and included: *Sicyopterus sarasini* Weber and de Beaufort, 1915, an endemic; *Sicyopterus lagocephalu*s (Pallas, 1774) widely distributed and known from the Comoros and Mascarene Islands in the western Indian Ocean to the Society Islands in French Polynesia and from the Ryukyu Islands of Japan to the Cape York Peninsula of Queensland, Australia (Keith *et al.* 2005; Lord *et al.* 2010); *Sicyopus zosterophorum* (Bleeker, 1857) known from eastern Indian Ocean drainages of Indonesia to Japan and New Caledonia; *Smilosicyopus chloe* (Watson, Keith & Marquet, 2001) from New Caledonia and Vanuatu (Watson *et al*. 2001); *Smilosicyopus fehlmanni* (Parenti & Maciolek, 1993) from Palau to New Caledonia; *Smilosicyopus pentecost* (Keith, Lord & Taillebois, 2010) from New Caledonia and from Vanuatu; *Stiphodon atratus* Watson, 1996 and *Stiphodon rutilaureus* Watson, 1996 known from eastern Indonesia, Vanuatu to New Caledonia (Watson 1996); *Lentipes kaaea* Watson, Keith & Marquet, 2002 known from New Caledonia, Futuna, Fiji and Vanuatu; *Stiphodon sapphirinus* Watson, Keith & Marquet, 2005 known from New Caledonia and Vanuatu; *Stiphodon mele* Keith, Lord & Pouilly, 2009 known from New Caledonia and Vanuatu; and the widespread *Stiphodon semoni* Weber, 1895.

Like most Pacific islands, New Caledonia is characterised by the absence of indigenous primary and secondary fishes that are intolerant to saltwater sensu Myers (1949) and Banarescu (1990). As a consequence of the absence of primary and

secondary native fishes, the rivers are then mainly colonised by diadromous fish (migrant amphihaline species performing a part of their biological cycle in freshwaters). These are represented by two categories: catadromous (Anguillidae (eels)) and amphidromous fish (Gobiidae, Eleotridae and Rhyacichthyidae).

Amphidromous gobiids have a life cycle adapted to the conditions of insular rivers subject to extreme climatic and hydrological seasonal variation. These species spawn in freshwaters, the free embryos drift downstream to the sea where they undergo a planktonic phase (dispersal phase), before returning to the rivers to grow and reproduce (McDowall 1997; Keith 2003; Keith *et al.* 2006). These gobies contribute most to the diversity of fish communities in the Indo-Pacific insular systems, and have the highest levels of endemism (Lord & Keith 2006, 2008; Keith & Lord 2011a; 2011b; Keith *et al.* 2011). Therefore, it is not surprising that Gobiidae represent 55.5% of the new records.

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