A NEW FRESHWATER GOBY OF RHINOGOBIUS (TELEOSTEI: GOBIIDAE) FROM HAINAN ISLAND, SOUTHERN CHINA

I-Shiung Chen
Institute of Marine Biology, National Taiwan Ocean University, Keelung, Taiwan, R.O.C., isc@ntou.edu.tw

Peter J. Miller
School of Biological Sciences, University of Bristol, Bristol, England, UK.

Follow this and additional works at: https://jmstt.ntou.edu.tw/journal

Part of the Aquaculture and Fisheries Commons

Recommended Citation
DOI: 10.6119/JMST-013-1219-10
Available at: https://jmstt.ntou.edu.tw/journal/vol21/iss7/16

This Research Article is brought to you for free and open access by Journal of Marine Science and Technology. It has been accepted for inclusion in Journal of Marine Science and Technology by an authorized editor of Journal of Marine Science and Technology.
A NEW FRESHWATER GOBY OF RHINOGOBIUS (TELEOSTEI: GOBIIDAE) FROM HAINAN ISLAND, SOUTHERN CHINA

Acknowledgements
The first author is very grateful for the grant support of the National Science Council, Taipei, Taiwan and he also wishes to thank the CMBB of NTOU, Keelung, for research grant concerning aquatic biodiversity in 2008-2009.
A NEW FRESHWATER GOBY OF *Rhinogobius* (TELEOSTEI: GOBIIDAE) FROM HAINAN ISLAND, SOUTHERN CHINA

I-Shiung Chen¹ and Peter J. Miller²

Key words: *Rhinogobius*, new species, Gobiidae, fish taxonomy, China.

ABSTRACT

A new freshwater goby of *Rhinogobius* Gill (1859) was collected from the Wangchuang River basin, Hainan Island, southern China. The new species, *Rhinogobius sangenloensis*, can be well distinguished from other congeners by a combination of the following features: second dorsal-fin rays modally I/8; anal-fin rays I/7-8; pectoral-fin rays modally 17; longitudinal scales 25-27; predorsal scales 9-11; vertebrae 26; body with 3-4 longitudinal, discontinuous orange to brown or brownish black bars and stripes; cheek with 2 grayish black spots in male; pectoral-fin base in male with 2 oblong black bars; caudal fin with an orange mark on lower 1/3 region in male. An artificial key to six species of *Rhinogobius* from Hainan Island is also provided.

I. INTRODUCTION

Freshwater gobies are very important component of benthic inland fish fauna in East Asia. The freshwater gobiid genus, *Rhinogobius* Gill (1859), is widely distributed on islands of the western Pacific including Japan (Akihito et al. [1, 2, 3]; Masuda et al. [26]; Suzuki et al. [30]), Taiwan (Chen and Shao [16]; Lee and Chang [15]; Chen et al. [14]; Chen and Fang [6]), Hainan (Wu and Ni [33]; Chen et al. [15]), and Philippines (Herre [21]) and also continental Asia, including Russia, Korea, China, Vietnam, Laos, Cambodia, and Thailand (Chu and Wu [19]; Chen and Miller [5, 13]; Chen et al. [5, 8, 17, 18]; Chen and Kottelat [9, 10, 11]; Li et al. [25]; Wu et al. [34]). The life history of *Rhinogobius* species indicates that the genus includes mainly amphidromous species and non-diadromous, fluvial species (Mizuno [28]; Akihito et al. [2, 3]; Chen and Fang [6, 7]; Huang and Chen [22]; Chen [4]; Iguchi and Mizuno [23]) as well as lake-river migratory species and lentic species (Takahashi and Okazaki [31]). At present, the first author (ISC) estimates that at least over 85 species are known in East and Southeast Asia and some of them still need formal description (Chen and Fang [7]; Chen and Miller [13]; Wu et al. [34]).

In Hainan Island, southern China, very high endemicity of this genus has revealed recently. Chen et al. [15] had firstly documented 4 non-diadromous, but endemic new species of *Rhinogobius* collected from four different river basins including *Rhinogobius changjiangensis* Chen et al., 2002; *Rhinogobius linshuiensis* Chen et al., 2002; *Rhinogobius nandujiangensis* Chen et al., 2002; and *Rhinogobius wangchuanensis* Chen et al., 2002. In December 2009, additional field expedition of freshwater fishes in river basins of Hainan Island had been conducted again by the first author. Collections from several mountainous brooks revealed that one undescribed freshwater goby was turned to light. The aim of this paper is to describe this as a new species of *Rhinogobius* in the Wangchuang River basin. An artificial key to all valid species of *Rhinogobius* from Hainan Island is also provided.

II. MATERIALS AND METHODS

Type specimens of the new species were collected by hand-net and cast-net. All counts and measurements were made from specimens preserved in 70% ethanol. Morphometric methods follow Miller [27] and meristic methods follow Akihito et al. [1], Chen and Fang [7], and Chen and Miller [12]. Terminology of cephalic sensory canals and free neuromast organs (sensory papillae) is from Wongrat and Miller [32] based on Sanzo [29]. Meristic abbreviations are as follows: A = anal fin; C = caudal fin; D1 = first dorsal fin; D2 = second dorsal fin; LR = longitudinal scales; PreD = predorsal scales; SDF = scales between first dorsal fin origin to upper pectoral fin origin; TR = transverse scale series from origin of second dorsal fin to base of anal fin; V = pelvic fin; and VC = vertebral count. All fish lengths are expressed by standard...
length (SL). The type specimens are deposited in the Pisces collections of National Taiwan Ocean University, Keelung (NTOUP). All comparative materials were listed in either Chen et al. [15] or Huang and Chen [22].

III. SYSTEMATICS

*Rhinogobius* Gill (1859)

Type species: *Rhinogobius similis* Gill (1859) by original designation.

*Rhinogobius sangenloensis* new species

(Figs. 1-4)

Material examined:


*Paratypes.* – NTOUP-2010-01-069, 6 specimens, 21.2-30.2 mm SL, other data same as holotype.

Diagnosis.

This new species, *Rhinogobius sangenloensis*, can be distinguished from all other congeners by the unique combination...
Table 1. Morphometry of *Rhinogobius sangenloensis*.

<table>
<thead>
<tr>
<th>Sex type status</th>
<th>male holotype</th>
<th>male paratype</th>
<th>male paratype</th>
<th>male paratype</th>
<th>female paratype</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size (mm SL)</td>
<td>31.6</td>
<td>30.2</td>
<td>28.9</td>
<td>28.2</td>
<td>29.4</td>
</tr>
<tr>
<td>% in SL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head length</td>
<td>31.3</td>
<td>31.4</td>
<td>30.5</td>
<td>32.2</td>
<td>29.8</td>
</tr>
<tr>
<td>Predorsal length</td>
<td>39.0</td>
<td>40.5</td>
<td>36.7</td>
<td>41.4</td>
<td>38.1</td>
</tr>
<tr>
<td>Snout to 2nd dorsal origin</td>
<td>58.3</td>
<td>56.1</td>
<td>56.1</td>
<td>58.6</td>
<td>58.3</td>
</tr>
<tr>
<td>Snout to anus</td>
<td>55.9</td>
<td>56.5</td>
<td>53.9</td>
<td>52.9</td>
<td>55.9</td>
</tr>
<tr>
<td>Snout to anal fin origin</td>
<td>59.6</td>
<td>62.3</td>
<td>58.9</td>
<td>62.3</td>
<td>62.0</td>
</tr>
<tr>
<td>Prepelvic length</td>
<td>31.6</td>
<td>33.2</td>
<td>31.3</td>
<td>31.7</td>
<td>30.4</td>
</tr>
<tr>
<td>Caudal peduncle length</td>
<td>27.0</td>
<td>24.9</td>
<td>27.1</td>
<td>26.1</td>
<td>27.3</td>
</tr>
<tr>
<td>Caudal peduncle depth</td>
<td>10.7</td>
<td>11.8</td>
<td>10.9</td>
<td>11.8</td>
<td>12.8</td>
</tr>
<tr>
<td>First dorsal fin base</td>
<td>9.6</td>
<td>9.7</td>
<td>10.1</td>
<td>8.6</td>
<td>9.9</td>
</tr>
<tr>
<td>Second dorsal fin base</td>
<td>14.5</td>
<td>17.6</td>
<td>14.5</td>
<td>14.4</td>
<td>16.1</td>
</tr>
<tr>
<td>Anal fin base</td>
<td>13.3</td>
<td>13.2</td>
<td>12.9</td>
<td>12.6</td>
<td>12.7</td>
</tr>
<tr>
<td>Caudal fin length</td>
<td>25.6</td>
<td>23.6</td>
<td>24.2</td>
<td>27.2</td>
<td>25.0</td>
</tr>
<tr>
<td>Pectoral fin length</td>
<td>23.8</td>
<td>24.4</td>
<td>24.0</td>
<td>26.2</td>
<td>25.2</td>
</tr>
<tr>
<td>Pelvic fin length</td>
<td>16.1</td>
<td>17.3</td>
<td>16.2</td>
<td>18.0</td>
<td>17.0</td>
</tr>
<tr>
<td>Body depth of pelvic fin origin</td>
<td>15.8</td>
<td>14.9</td>
<td>15.4</td>
<td>15.2</td>
<td>15.7</td>
</tr>
<tr>
<td>Body depth of anal fin origin</td>
<td>15.0</td>
<td>15.3</td>
<td>13.8</td>
<td>15.4</td>
<td>16.5</td>
</tr>
<tr>
<td>Body width of anal fin origin</td>
<td>12.8</td>
<td>13.1</td>
<td>10.7</td>
<td>11.3</td>
<td>11.3</td>
</tr>
<tr>
<td>Pelvic fin origin to anus</td>
<td>23.8</td>
<td>25.0</td>
<td>25.2</td>
<td>20.2</td>
<td>27.6</td>
</tr>
<tr>
<td>% in HL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Snout length</td>
<td>38.5</td>
<td>39.1</td>
<td>34.2</td>
<td>38.1</td>
<td>32.6</td>
</tr>
<tr>
<td>Eye diameter</td>
<td>21.1</td>
<td>22.4</td>
<td>20.4</td>
<td>22.4</td>
<td>23.9</td>
</tr>
<tr>
<td>Postorbital length</td>
<td>50.1</td>
<td>52.3</td>
<td>53.7</td>
<td>48.1</td>
<td>52.3</td>
</tr>
<tr>
<td>Cheek depth</td>
<td>23.4</td>
<td>23.8</td>
<td>24.3</td>
<td>21.2</td>
<td>18.9</td>
</tr>
<tr>
<td>Head width in upper gill opening</td>
<td>43.5</td>
<td>44.9</td>
<td>39.0</td>
<td>39.4</td>
<td>45.3</td>
</tr>
<tr>
<td>Head width in maximum</td>
<td>64.2</td>
<td>65.1</td>
<td>56.7</td>
<td>63.1</td>
<td>62.8</td>
</tr>
<tr>
<td>Fleshy interorbital width</td>
<td>26.9</td>
<td>24.9</td>
<td>24.0</td>
<td>21.4</td>
<td>23.1</td>
</tr>
<tr>
<td>Bony interorbital width</td>
<td>6.8</td>
<td>6.1</td>
<td>5.6</td>
<td>5.8</td>
<td>5.1</td>
</tr>
<tr>
<td>Lower jaw length</td>
<td>35.5</td>
<td>34.9</td>
<td>37.1</td>
<td>38.1</td>
<td>30.5</td>
</tr>
<tr>
<td>% in caudal peduncle length</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caudal peduncle depth</td>
<td>39.8</td>
<td>47.3</td>
<td>40.3</td>
<td>45.1</td>
<td>46.9</td>
</tr>
</tbody>
</table>

of following features: second dorsal-fin rays modally I/8; anal-fin rays I/7-8; pectoral-fin rays modally 17; longitudinal scales 25-27; predorsal scales 9-11; vertebrae 10 + 16 = 26; body with 3-4 longitudinal, discontinuous orange to brown or brownish black bars and stripes; cheek with 2 basal grayish black spots; pectoral-fin base in male with 2 oblong black bars; caudal fin with an orange mark on lower 1/3 region in male.

**Description.**


**Fins.** – D1 V-VII (modally VI); D2 I/8-9 (modally 8); A I/7-8; P 16-17 (modally 17); V I/5+I/5 (distribution frequency in Table 2). 3rd and 4th spinous rays of D1 slightly longer than other spinous rays, with rear tip extending just to origin of D2 when depressed in male; not extending to origin of D2 when depressed in female. Origin of A inserted below origin of 1st branched ray of D2. Rear margins of D2 and A rays when depressed not reaching the procurent rays of C. P large and oblong, its rear tip not extending to vertical of anus in both sexes.

**Scales.** – Body with moderate large ctenoid scales; posterior pseudor region with cycloid scales, extending laterally to above the gap between anterior and posterior oculoscapular canals. LR 25-27 (modally 26); TR 9-10 (modally 10); PreD 9-11; and SDP 8. Head and prepelvic region naked. Anterior edge of midpredorsal squamation extending to about the vertical through middle of posterior oculoscapular canals.
Table 2. Comparison of frequency distribution of meristic counts of 6 *Rhinogobius* species from Hainan Island, China.

<table>
<thead>
<tr>
<th>Species</th>
<th>D1</th>
<th>D2</th>
<th>L</th>
<th>A</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>R. sengloensis</em> n. sp.</td>
<td>2</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td><em>R. leavelli</em></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td><em>R. changjiangensis</em></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td><em>R. linshuiensis</em></td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td><em>R. nanduijiangensis</em></td>
<td>-</td>
<td>-</td>
<td>10</td>
<td>-</td>
<td>6</td>
</tr>
<tr>
<td><em>R. wangchuangensis</em></td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>5.8</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Species</th>
<th>LR</th>
<th>TR</th>
<th>SDP</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>R. sengloensis</em> n. sp.</td>
<td>25</td>
<td>26</td>
<td>27</td>
</tr>
<tr>
<td><em>R. leavelli</em></td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><em>R. changjiangensis</em></td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><em>R. linshuiensis</em></td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><em>R. nanduijiangensis</em></td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><em>R. wangchuangensis</em></td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**PreD**

<table>
<thead>
<tr>
<th>Species</th>
<th>PreD</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>R. sengloensis</em> n. sp.</td>
<td>-</td>
</tr>
<tr>
<td><em>R. leavelli</em></td>
<td>-</td>
</tr>
<tr>
<td><em>R. changjiangensis</em></td>
<td>-</td>
</tr>
<tr>
<td><em>R. linshuiensis</em></td>
<td>-</td>
</tr>
<tr>
<td><em>R. nanduijiangensis</em></td>
<td>-</td>
</tr>
<tr>
<td><em>R. wangchuangensis</em></td>
<td>-</td>
</tr>
</tbody>
</table>

**VC**

<table>
<thead>
<tr>
<th>Species</th>
<th>VC</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>R. sengloensis</em> n. sp.</td>
<td>-</td>
</tr>
<tr>
<td><em>R. leavelli</em></td>
<td>-</td>
</tr>
<tr>
<td><em>R. changjiangensis</em></td>
<td>-</td>
</tr>
<tr>
<td><em>R. linshuiensis</em></td>
<td>-</td>
</tr>
<tr>
<td><em>R. nanduijiangensis</em></td>
<td>-</td>
</tr>
<tr>
<td><em>R. wangchuangensis</em></td>
<td>-</td>
</tr>
</tbody>
</table>

**PS:** M = the mean of all values

*R. leavelli* from Huang and Chen (2007) and NTOUP 2010-05-075

**Head lateral-line system.** (Fig. 2)


**Papillae.** – Row a short, not reaching the middle vertical of line of orbit. Row b short, slightly longer than a half of eye diameter. Row c and d longer than row b. A single cp papilla. Row f paired. Rows ot and of well separate.

**Coloration in fresh material.** (Figs. 1, 3)

Head and body creamy white to light brown; body having 3-4 longitudinal, discontinuous orange to brown or brownish black bars and stripes. Body with 4-6 X-shaped blackish brown marks in female. Caudal fin base with a median deep black spot in male and a horizontal bar in female. Head grayish-brown to yellowish brown. Dorsal side of snout with a pair of deep black stripes united to snout tip. Cheek always with 2 grayish black spots on lower margin in male, but spotless in female. A grayish mark along lower margin of orbit. A broad longitudinal grayish stripes on middle region of cheek. Branchiostegal membrane grayish brown with 16-24 bright red spots for each side in male, but uniform grayish and spotless in female.

First dorsal fin pale white with median, transverse deep black bars anteriorly in front of 3rd or 4th spinous rays and basal region of spinous rays with row of small brown spots in male; translucent with 3-4 rows of brown and grayish spots in female. Second dorsal fin grayish with 4-5 rows of brown spots and darker on distal half and in having a thin second margin in male; translucent with 4 rows of black spots and a grayish distal margin in female. Anal fin orange red with black distal margin in male; light gray and translucent in female. Pectoral fin grayish with basal semicircular creamy white region and one upper horizontal black bar and one lower oblique black bar in male; translucent with a longitudinal blackish brown bar and a lower brown spot in female. Caudal fin grayish with 5-6 nearly vertical rows of brown bars or spots, grayish black distally, and an orange mark in lower 1/3 region in male; translucent with 5-7 vertical rows of grayish black spots in female. Pelvic fin deep gray and basal 1/3 region of rays pale orange in male; but whitish and translucent in female.
Distribution
This species was collected from the small tributary of Wangchuang River basin around “Sangenlo” township, Wang-Ning County, Hainan Island, southern China.

Habitat
The new species prefers a hill-stream habitat with moderate to slow current over small to medium-sized pebbles, water depth ranging from 15-70 cm.

Etymology
The specific name, “sangenloensis”, refers to the type locality as the small tributary of Wangchuang River basin, at “Sangenlo” Township, Wang-Ning County, Hainan Island, southern China.

Remarks:
So far, there are four nondiadromous, fluvial species of Rhinogobius species in four different basins as R. changjiangensis from the Changhuajiang River basin; R. linshuiensis from the Linshui River basin; R. nandujiangensis from the Nandujiang River basin; and R. wangchuanensis from the Wangchuang River basin, Hainan. These four endemic species show very limited distribution range merely found from the few upper tributaries of their drainages even with more field exploration done in recent years. In opposite, the dominant amphidromous species, Rhinogobius leavelli, is rather common in most upper, middle and lower reaches of major river basins (Chen et al. 2002). This new goby, Rhinogobius sangenloensis, is also only distributed in one tributary of the Wangchuang River basin.

Rhinogobius sangenloensis differs from rather common amphidromous Rhinogobius leavelli by longitudinal scales 25-27 (vs. 32-35); pectoral-fin rays 16-17, modally 17 (vs. 18-20, modally 19); pectoral-fin base in male with 2 oblong black bars (vs. with a transverse, broad orange to deep brown curve); cheek with two black spots on lower region in male (vs. no black spots but with some small orange spots in male); and caudal fin with an orange mark on lower 1/3 region in male (vs. no such orange mark).

In comparison with the remaining four fluvial, endemic congeners of Hainanese endemic, Rhinogobius sangenloensis can be distinguished from R. nandujiangensis by first dorsal fin without filamentous rays in male (vs. first dorsal fin with filamentous rays extending when depressed to origin of fourth or fifth branched rays of second dorsal fin in male); rear tip of second dorsal fin extending to margin of caudal fin base in male; 25 vertebrae (Nandujiang River drainage) —— R. nandujiangensis

1b First dorsal fin without distinct filamentous ray, rear tip of second dorsal fin not reaching vertical through caudal fin base in both sexes; 26-28 vertebrae —— R. leavelli

1b First dorsal fin without distinct filamentous ray, rear tip of second dorsal fin not reaching vertical through caudal fin base in both sexes; 26-28 vertebrae —— R. leavelli

Rhinogobius sangenloensis can be distinguished from R. changjiangensis by first dorsal fin without filamentous rays in male (vs. first dorsal fin with filamentous rays extending when depressed to base of fourth or fifth branched rays of second dorsal fin in male of R. nandujiangensis); rear tip of second dorsal fin not reaching vertical through caudal fin base in male (vs. rear tip of second dorsal fin extending to margin of caudal fin base in male); cheek always with two round brownish black spots in lower region in male (vs. one oblique brown stripe in male); and vertebrae 26 (vs. modally 25).

Rhinogobius sangenloensis can be distinguished from R. changjiangensis by first dorsal fin without filamentous rays in male (vs. first dorsal fin with filamentous rays extending when depressed to base of fourth or fifth branched rays of second dorsal fin in male of R. nandujiangensis); rear tip of second dorsal fin not reaching vertical through caudal fin base in male (vs. rear tip of second dorsal fin extending to margin of caudal fin base in male); cheek always with two round brownish black spots in lower region in male (vs. one oblique brown stripe in male); and vertebrae 26 (vs. modally 25).

Diagnostic key to species of Rhinogobius from Hainan Island, southern China:

1a First dorsal fin with distinctly filamentous rays extending when depressed to origin of fourth or fifth branched rays of second dorsal fin in male; rear tip of second dorsal fin extending to margin of caudal fin base in male; 25 vertebrae (Nandujiang River drainage) —— R. nandujiangensis

1b First dorsal fin without distinct filamentous ray, rear tip of second dorsal fin not reaching vertical through caudal fin base in both sexes; 26-28 vertebrae —— R. leavelli

2a Pectoral-fin rays 18-20; longitudinal scales 32-35; pectoral-fin base with a nearly vertical, orange to dark brown curve —— R. leavelli

2b Pectoral-fin rays 15-17; longitudinal scales less than 32; pectoral-fin base without such mark —— R. nandujiangensis

2a Pectoral-fin rays 18-20; longitudinal scales 32-35; pectoral-fin base with a nearly vertical, orange to dark brown curve —— R. leavelli

3a Vertebrae 26 —— R. nandujiangensis

3b Vertebrae 27-28 —— R. leavelli

4a Predorsal scales 9-12; gill opening extending anterioventrally to a vertical through middle of opercle; pectoral-fin base with 2 vertical black bars in male; cheek with 2 basal brown spots in male (Wangchuang River drainage) —— R. sangenloensis

4a Predorsal scales 9-12; gill opening extending anterioventrally to a vertical through middle of opercle; pectoral-fin base with 2 vertical black bars in male; cheek with 2 basal brown spots in male (Wangchuang River drainage) —— R. sangenloensis

4b Predorsal scales 2-3; gill opening extending to a vertical through rear margin of preopercle; pectoral-fin base with inverted “L” shape blackish brown mark; cheek spotless in male (Changhwajiang River drainage) —— R. changjiangensis

5a Predorsal scales 7-11 (modally 9); cheek with two rows of totally 6-10 brownish red spots in male; sides of body without dark cross bars but with two horizontal rows of red spots (Linshui River drainage) —— R. linshuiensis

5b Predorsal scales 3-6 (modally 5); cheek with two round black spots in both sexes; sides of body with seven or
eight square grayish black cross bars (Wangchuang River drainage)--- R. wangchuangensis

ACKNOWLEDGMENTS

The first author is very grateful for the grant support of the National Science Council, Taipei, Taiwan and he also wishes to thank the CMBB of NTOU, Keelung, for research grant concerning aquatic biodiversity in 2008-2009.

REFERENCES