MONOGENEANS FROM PANGASIIDAE (SILURIFORMES) IN SOUTHEAST ASIA: IV. FIVE NEW SPECIES OF *THAPAROCLEIDUS* JAIN, 1952 (ANCYLODISCOIDIDAE) FROM *PANGASIUS KREMPFI*, *P. KUNYIT*, *P. MEKONGENSIS* AND *P. SABAHENSIS*

PARISELLE A.*,**, LIM L.H.S.*** & LAMBERT A.****

Summary:

The examination of gill parasites from *Pangasius krempfi* Roberts & Vidthayanon, 1991; *P. kunyit* Pouyaud *et al.*, 1999; *P. mekongensis* Gustiano *et al.*, in press and *P. sabahensis* Gustiano *et al.*, in press (Siluriformes, Pangasiidae) in Southeast Asia revealed the presence of six species of Monogenea, all belonging to the genus *Thaparocleidus* Jain, 1952 (Monogenea, Ancylodiscoididae) as defined by Lim (1996) and Lim *et al.* (2001). One has been previously described (*T. vietnamensis* Pariselle *et al.*, 2002), five are considered as new species: *T. humerus* n. sp. and *T. culter* n. sp. on *P. kunyit*; *T. mehurus* n. sp. and *T. culteroides* n. sp. on *P. sabahensis*; and *T. phuongi* n. sp. on the four studied host species. The latter one, due to slight morphometric differences linked to geographical origin of hosts, is described as made up of three sub-species: *T. phuongi phuongi* n. sub-sp., *T. phuongi malaysiensis* n. sub-sp. and *T. phuongi indonesiensis* n. sub-sp.

KEY WORDS : Monogenea, Ancylodiscoididae, *Thaparocleidus culter* n. sp., *Thaparocleidus culteroides* n. sp., *Thaparocleidus humerus* n. sp., *Thaparocleidus mehurus* n. sp., *Thaparocleidus phuongi* n. sp. (*Thaparocleidus phuongi phuongi* n. sub-sp., *Thaparocleidus phuongi malaysiensis* n. sub-sp., *Thaparocleidus phuongi indonesiensis* n. sub-sp.), freshwater fish, Siluriformes, Pangasiidae, *Pangasius krempfi*, *Pangasius kunyit*, *Pangasius mekongensis*, *Pangasius sabahensis*, South East Asia.

Résumé : MONOGÈNES DE PANGASIIDAE (SILURIFORMES) EN ASIE DU SUD-EST : IV. CINQ ESPÈCES NOUVELLES DE *THAPAROCLEIDUS* JAIN, 1952 (ANCYLODISCOIDIDAE) CHEZ *PANGASIUS KREMPFI*, *P. KUNYIT*, *P. SABAHENSIS* ET *P. MEKONGENSIS*

L'examen des parasites branchiaux de Pangasius krempfi *Roberts & Vidthayanon, 1991; P. kunyit Pouyaud* et al., *1999;* P. mekongensis *Gustiano* et al., *sous presse et* P. sabahensis *Gustiano* et al., *sous presse (Siluriformes, Pangasiidae) a révélé la présence de six espèces de Monogenea appartenant toutes au genre* Thaparocleidus *Jain, 1952 (Ancylodiscoidinae) tel que défini par Lim (1996) et Lim* et al. *(2001). Une a été précédemment décrite (*T. vietnamensis *Pariselle* et al., *2002), cinq sont considérées comme nouvelles :* T. humerus *n. sp. et* T. culter *n. sp. sur* P. kunyit *;* T. mehurus *n. sp. et* T. culteroides *n. sp. sur* P. sabahensis *et* T. phuongi *n. sp. sur les quatre espèces hôtes étudiées. Cette dernière, du fait de légères différences morphométriques liées à l'origine géographique des hôtes, est décrite sous la forme de trois sous-espèces :* T. phuongi phuongi *n. sub-sp.,* T. phuongi malaysiensis *n. sub-sp. et* T. phuongi indonesiensis *n. sub-sp.*

MOTS CLÉS : *Monogenea, Ancylodiscoididae,* Thaparocleidus culter *n. sp.,* Thaparocleidus culteroides *n. sp.,* Thaparocleidus humerus *n. sp.,* Thaparocleidus mehurus *n. sp.,* Thaparocleidus phuongi *n. sp.* (Thaparocleidus phuongi phuongi *n. sub-sp.,* Thaparocleidus phuongi malaysiensis *n. sub-sp.,* Thaparocleidus phuongi indonesiensis *n. sub-sp.), poissons d'eau douce, Siluriformes, Pangasiidae,* Pangasius krempfi, Pangasius kunyit, Pangasius mekongensis, Pangasius sabahensis, *Asie du Sud Est.*

INTRODUCTION

Within the framework of an European Commission project on the bio-diversity and culture of Southeast Asian catfishes, the gills of pangasiid fishes (Siluriformes, Pangasiidae) were examined for monogeneans. This fourth paper (see Pariselle *et al.*, 2001a, 2001b and 2002) presents the descriptions of five new species of *Thaparocleidus* Jain, 1952 (Monogenea, Ancylodiscoididae) found on four *Pangasius* species (*P. krempfi* Roberts & Vidthayanon, 1991; *Pangasius kunyit* Pouyaud *et al.*, 1999; *P. mekongensis* Gustiano *et al.*, in press and *P. sabahensis* Gustiano *et al.*, in press). These fish species were collected in Indonesia (Borneo and Sumatra Islands), Malaysia (Borneo Island) and Vietnam (Mekong Delta) and have not been previously examined for parasites. The monogeneans from the other pangasiid species will be described elsewhere.

To date a total of 17 species of *Thaparocleidus* have been described from ten *Pangasius* species (*Pangasius bocourti* Sauvage, 1880; *P. djambal* Bleeker, 1846; *P. gigas* Chevey, 1930 *P. humeralis* Roberts, 1989; *P. hypophthalmus* (Sauvage, 1878); *P. kinabatanganensis* Roberts & Vidthayanon, 1991; *P. lithostoma* Roberts, 1989; *P. nieuwenhuisii* (Popta, 1904); *P. pangasius* (Hamilton, 1822) and *P. rheophilus* Pouyaud *et al.*, 2000) from India, Bangladesh, Indonesia, Malaysia,

* IRD (ex ORSTOM), Catfish Asia Project, Instalasi Penelitian Perikanan Air Tawar, Jalan Ragunan-Pasar Minggu, PO Box 7220/jkspm, Jakarta 12540, Indonesia.
** GAMET, BP 5095, 34033 Montpellier Cedex 1, France.
*** Institute of Biological Sciences, University of Malaya, 50603 Kuala Lumpur, Malaysia.
**** Laboratoire Génome, Populations, Interactions, UMR 5000, cc 92, Université Montpellier II, Sciences et Techniques du Languedoc, Place Eugène Bataillon, 34095 Montpellier Cedex 5, France.
Correspondence: A. Lambert. E-mail: lambert@crit.univ-montp2.fr

Thailand and Vietnam (see Tripathi, 1957; Lim, 1990; Pariselle *et al.*, 2001a, 2001b and 2002).

MATERIALS AND METHODS

Fish were bought in fish markets or directly from fishermen in Indonesia (Kalimantan region, part of Borneo Island and Sumatra Island), Malaysia (Sabah states, north part of Borneo Island) and Vietnam. Fish were caught in the rivers using hook and line or from aquaculture facilities. The fish were dissected as soon as possible, and the left branchial arches were frozen in liquid nitrogen, until examination. To verify the specific identity of host fishes, the carcasses were numbered, fixed and preserved in formalin. In the laboratory, the gills were thawed and the monogeneans were detached from the gill using a strong water current. The worms were then transferred individually on a slide with a mounted needle, directly into a drop of ammonium picrate-glycerine (mixture described by Malmberg (1957)). The preparation was then covered with a round cover slip and sealed with Glyceel (GURR-BDH Chemicals Ltd.). From these preparations, drawings were made of the sclerotised pieces of the haptor and of the copulatory complex using a camera lucida. Measurements, made with a digitiser, in micrometers are presented as the mean ± standard deviation followed by the range in parentheses, are those proposed by Gussev (1962) (Fig. 1). The method of numbering of the haptoral pieces is that adopted at ICOPA IV (Euzet & Prost, 1981). Termino-

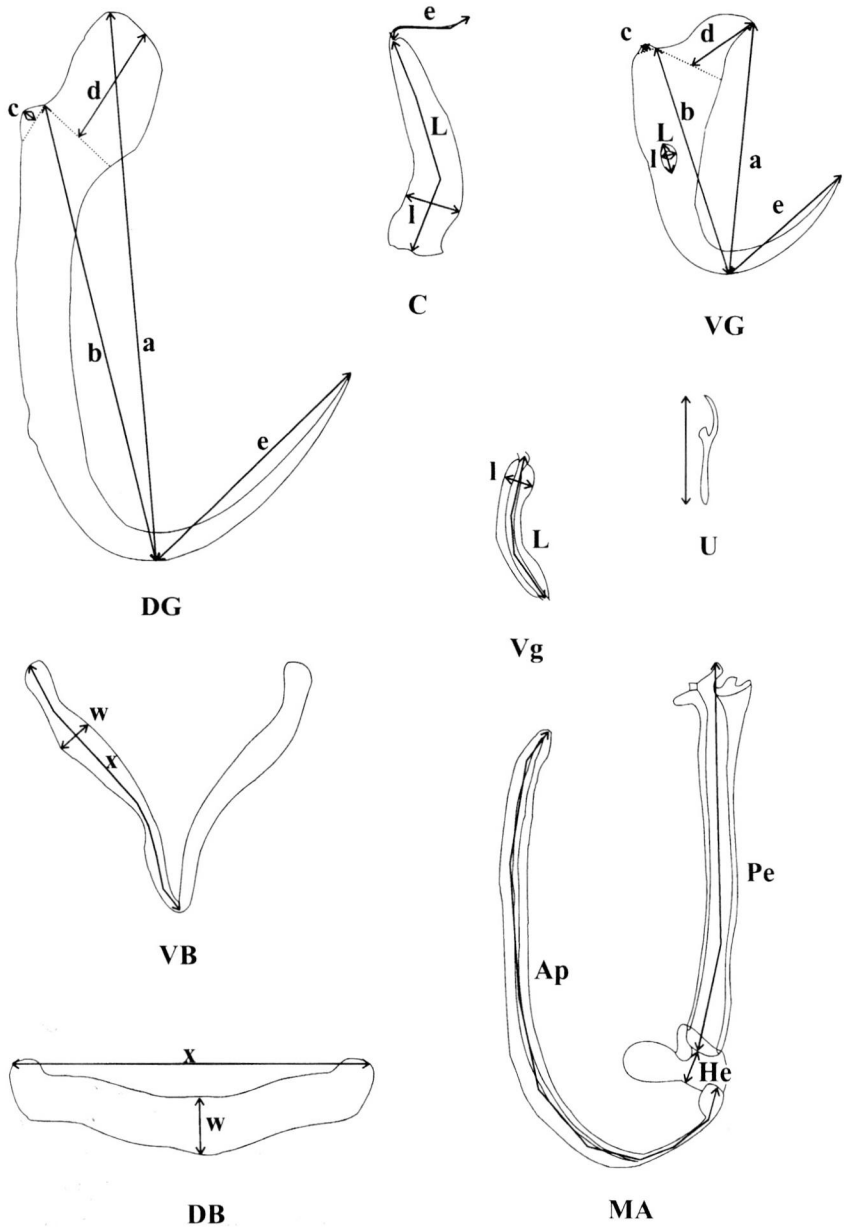

Fig. 1. – Measurements used in this study.
C = cuneus: L = length; l = largest width; e = extension length.
DB = dorsal transverse bar: x = total length; w = width in the middle.
DG = dorsal gripus: a, b, c, d and e = standard measurements.
MA = male apparatus: Pe = total length of the penis; Ap = length of the accessory piece; He = length of the heel.
U = total length of the uncinuli.
VB = ventral transverse bar: x = length of one branch; w = largest width.
VG = ventral gripus: a, b, c, d and e = standard measurements; L and l = length and width of gripus aperture.
Vg = vagina: L = total length; l = maximum width.

logies used are those of Pariselle & Euzet (1995) and N'Douba *et al.* (1999).
Principal component analyses (PCA) were done on the measurements of the hard parts only (genitalia and haptor), the total length, width at level of the penis and the pharynx diameter are omitted, because these measurements are too dependent on the variable quantity of ammonium picrate-glycerine used to make the slides (see for example the wide range of these measurements for subspecies of *T. phuongi* n. sp. while measurements of hard parts are homogeneous in Table II).

RESULTS

Six monogenean species were recorded in Southeast Asia from *Pangasius krempfi* Roberts & Vidthayanon, 1991; *P. kunyit* Pouyaud *et al.*, 1999; *P. mekongensis* Gustiano *et al.*, in press and *P. sabahensis* Gustiano *et al.*, in press (Siluriformes, Pangasiidae). One has been previously described (see "Discussion" below) on *Pangasius bocourti* Sauvage, 1880 (*T. vietnamensis* Pariselle *et al.*, 2002) and was found also on *P. mekongensis*, five are considered new (see descriptions below), their anatomy (soft and hard parts) complies with that of *Thaparocleidus* Jain, 1952 (Monogenea, Ancylodiscoididae) as defined by Lim (1996) and Lim *et al.* (2001): Ancylodiscoididae. Three pairs of head glands. Two pairs of eye-spots. Haptor slightly separated from body. Haptoral sclerites include two pairs of anchors, with patches on dorsal anchor; two connecting bars, with dorsal single and ventral bar single or paired; and seven pairs of marginal hooks. Ovary antero-ventral to testis; uterine pore ventral near copulatory organ. Dextral vaginal opening sclerotised or non-sclerotised. Vas deferens arising from anterior region of testis, crossing to left, looping intestinal caecum to ventral side, ascending, forming blind saccular seminal vesicle; ductus ejaculatorius leaving seminal vesicle entering proximal part of copulatory organ. Parasites of freshwater catfishes of Eurasia and Southeast Asia.

DESCRIPTIONS

THAPAROCLEIDUS HUMERUS N. SP. (Fig. 2, Table I)

Type-host: *Pangasius kunyit* Pouyaud *et al.*, 1999.
Site: gills.
Type-locality: Mahakam River at Samarinda (East Kalimantan province, Borneo Island, Indonesia).
Other locality: also found on the same host in the Musi River at Palembang (South Sumatra province, Sumatra Island, Indonesia).

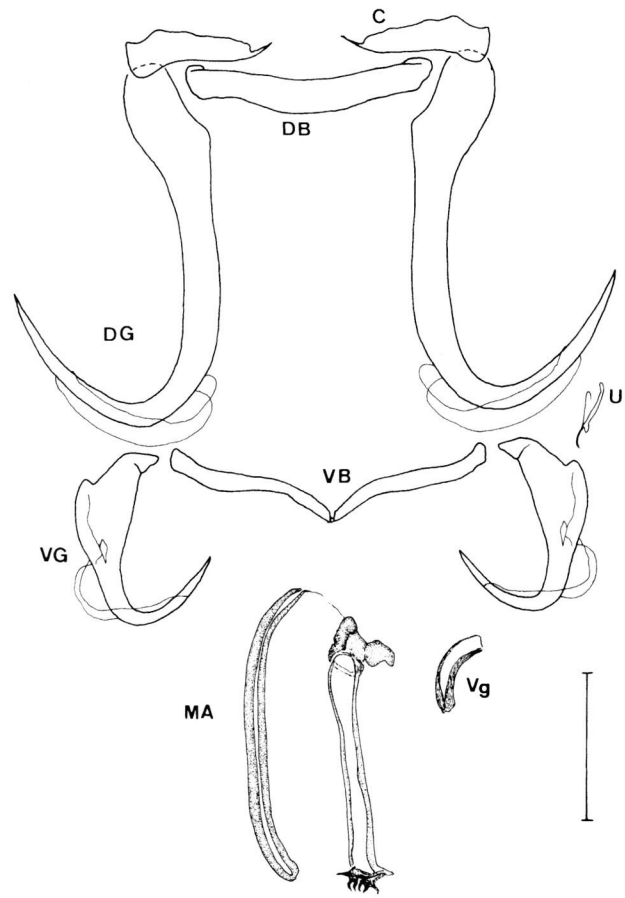

Fig. 2. – *Thaparocleidus humerus* n. sp.
C = cuneus; DB = dorsal transverse bar; DG = dorsal gripus; MA = male apparatus; VB = ventral transverse bar; VG = ventral gripus; Vg = vagina; U = uncinuli. Bar = 30 µm.

Material studied: 30 individuals fixed and mounted in ammonium picrate-glycerine solution.
Type-material: holotype deposited at the Muséum National d'Histoire Naturelle (Paris): 45HG Tg 191. Paratypes deposited at the Muséum National d'Histoire Naturelle (Paris): 45HG Tg 192; The Natural History Museum (London): n° 2002.3.7.3.

Measurements are given in Table I. Dorsal gripus with blade bend at distal third and poorly developed guard. Large cuneus with short extension. Nearly straight dorsal transverse bar. Ventral gripus with marked aperture and poorly developed guard. Thin V-shaped ventral transverse bar with rounded extremities. Large and straight penis (same diameter along entire length) with poorly developed basal bulb, ending in a crown of digitations, well developed heel. Long, slightly curved accessory piece linked to the basal bulb of the penis by a short stalk. Short, slightly curved, sclerotised vagina.

Comments

This new species is easily distinguished from all previously described *Thaparocleidus* spp from *Pangasius*

Species	*T. humerus*				*T. meburus*				*T. culter*				*T. culteroides*			
Measurements	Mean	St. D.	Min	Max	Mean	St. D.	Min	Max	Mean	St. D.	Min	Max	Mean	St. D.	Min	Max
Total length	780.0	121.8	526.2	1049.8	526.7	65.6	418.1	662.5	804.7	119.7	552.5	1088.6	447.3	72.5	355.1	629.6
Width at level of penis	136.8	15.3	105.2	163.7	86.4	15.8	54.9	115.8	165.9	27.8	116.9	213.2	81.5	15.0	55.8	121.3
Pharynx diameter	57.7	7.8	41.1	75.3	34.5	5.7	25.9	50.2	68.0	7.4	53.1	87.7	35.5	5.9	23.0	48.7
Copulatory tube total length	47.3	3.7	40.4	53.7	53.6	1.5	51.6	56.4	66.8	2.8	62.4	76.6	44.9	1.3	41.8	47.6
Heel	7.5	1.0	5.6	9.3	7.9	0.6	6.8	9.4	11.9	1.7	9.7	16.7	8.6	1.0	6.8	11.1
Accessory piece total length	55.5	5.0	47.8	65.7	53.7	2.3	49.3	58.5	39.6	3.2	34.7	46.9	25.3	1.3	22.8	28.4
Vagina total length	16.7	1.5	13.8	19.3	8.6	1.0	6.4	10.9								
Vagina width	3.8	0.4	3.1	4.5	4.0	0.6	2.6	5.5								
Uncinuli II total length	16.0	1.3	12.2	19.2	15.7	0.9	11.8	17.5	14.8	0.9	12.9	16.7	12.9	0.8	10.9	14.4
Other uncinuli total length	12.5	1.4	8.5	15.0	12.7	0.9	8.6	14.7	13.8	1.4	9.7	16.9	12.1	0.9	9.2	14.3
Dorsal transverse bar length	46.1	1.9	42.5	49.6	34.7	0.9	33.2	36.9	51.1	2.7	45.6	56.2	35.1	1.0	32.7	36.8
Dorsal transverse bar width	6.9	0.6	5.8	7.7	4.2	0.5	3.1	5.5	5.8	0.6	4.5	7.2	3.7	0.4	2.6	4.8
Cuneus length	27.7	1.5	24.3	32.4	22.2	1.0	20.1	24.1	19.6	1.3	17.2	22.7	13.0	1.1	10.5	15.3
Cuneus extension length	10.6	1.8	6.7	13.9	6.8	1.2	3.9	9.5	13.6	2.7	5.8	18.5	9.6	1.7	5.9	13.4
Cuneus maximum width	8.1	0.6	6.7	9.3	6.0	0.4	5.2	6.9	6.7	0.8	3.9	8.0	4.2	0.5	2.6	5.0
Dorsal gripus a	67.8	3.9	60.9	75.6	52.5	1.4	49.4	55.5	61.0	2.2	56.1	66.1	44.0	1.3	41.6	47.4
Dorsal gripus b	56.4	2.8	50.9	62.2	43.7	1.3	40.9	46.7	48.6	1.9	45.4	52.3	35.3	1.2	32.8	38.0
Dorsal gripus c	1.6	0.4	1.0	2.5	1.3	0.3	0.5	2.0	1.4	0.3	0.8	2.9	1.0	0.2	0.5	1.4
Dorsal gripus d	15.1	1.5	12.3	18.0	10.8	0.8	9.1	12.5	15.2	1.0	13.1	17.2	10.7	0.9	9.2	12.9
Dorsal gripus e	33.4	2.0	27.4	37.0	26.1	1.0	24.1	29.0	32.8	1.5	29.9	36.4	23.8	0.9	21.9	25.5
One branch of ventral bar length	34.9	1.3	32.3	38.2	27.4	0.9	25.5	29.5	44.1	1.9	39.3	49.0	37.3	1.7	33.0	40.9
Ventral bar width	4.4	0.5	3.7	5.4	3.0	0.3	2.6	3.6	4.1	0.3	3.4	4.9	2.8	0.4	2.0	3.8
Ventral gripus a	31.3	1.3	28.9	34.5	27.4	0.6	25.6	29.1	29.2	1.1	26.4	31.5	22.5	0.6	20.9	23.9
Ventral gripus b	27.3	1.2	25.3	30.4	25.2	0.7	23.6	26.8	24.0	1.1	21.4	26.3	18.8	0.7	17.4	21.2
Ventral gripus c	1.5	0.4	0.8	2.3	1.9	0.3	1.3	2.9	1.4	0.6	0.5	4.0	1.2	0.4	0.5	2.3
Ventral gripus d	10.8	0.9	8.5	12.8	9.6	0.6	8.3	11.0	9.4	0.9	6.7	11.3	6.7	0.9	5.1	9.9
Ventral gripus e	19.9	1.0	17.7	22.3	15.0	0.7	13.4	16.5	18.2	0.7	16.2	19.8	14.9	0.6	13.9	18.1
Ventral gripus aperture length	4.0	0.6	2.8	5.3	3.7	0.5	2.6	5.0	5.0	0.5	3.5	6.1	4.4	0.6	3.0	6.4
Ventral gripus aperture width	1.7	0.4	0.6	2.6	1.1	0.4	0.4	2.4	2.3	0.3	1.4	3.2	1.9	0.4	1.3	2.8

Table I. – Measurements from *T. humerus* n. sp.; *T. meburus* n. sp.; *T. culter* n. sp. and *T. culteroides* n. sp.

hosts in having a straight and large penis ending with a crown of digitations.

Thaparocleidus humerus n. sp. is named for the shape of the copulatory tube which resembles the human humerus bone.

THAPAROCLEIDUS MEHURUS N. SP. (Fig. 3, Table I)

Type-host: *Pangasius sabahensis* Gustiano *et al.*, in press.

Site: gills.

Type-locality: Kinabatangan River (Sabah State, Borneo Island, Malaysia).

Material studied: 30 individuals fixed and mounted in ammonium picrate-glycerine solution.

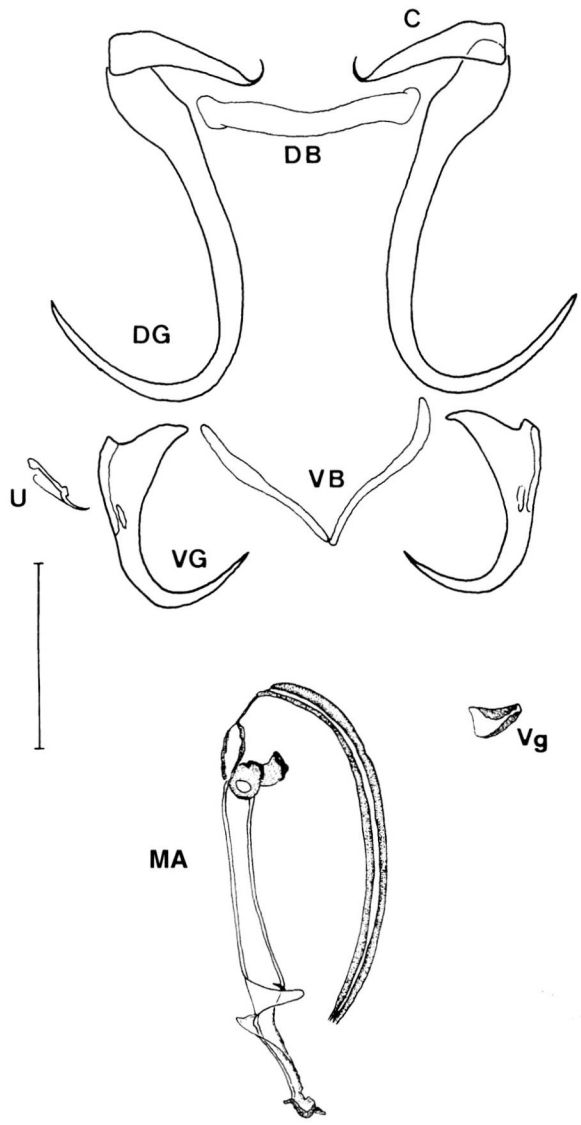

Fig. 3. – *Thaparocleidus meburus* n. sp.
C = cuneus; DB = dorsal transverse bar; DG = dorsal gripus; MA = male apparatus; VB = ventral transverse bar; VG = ventral gripus; Vg = vagina; U = uncinuli. Bar = 30 µm.

Type-material: holotype deposited at the Muséum National d'Histoire Naturelle (Paris): 46HG Tg 193. Paratypes deposited at the Muséum National d'Histoire Naturelle (Paris): 46HG Tg 194; The Natural History Museum (London): n° 2002.3.7.4.

The morphology of hard parts is identical to *T. humerus* n. sp. except for the penis which presents a distal third with a reduced diameter and a thin velum-like expansion, and for the sclerotised vagina which is shorter. Measurements are given in Table I.

Comments

This new species is distinguished from *T. humerus* n. sp. by the shape of the penis (see upper) and by the mean length (no overlapping of the ranges) of: the vagina (8.6 *vs.* 16.7 µm), the dorsal and ventral transverse bars (34.7 *vs.* 46.1 µm; 27.4 *vs.* 34.9 µm), the cuneus (22.2 *vs.* 27.7 µm), the dorsal gripus total length "a" (52.5 *vs.* 67.8 µm).

Thaparocleidus meburus n. sp. is named by an anagram of the name of the related species *T. humerus* n. sp.

THAPAROCLEIDUS CULTER N. SP. (Fig. 4, Table I)

Type-host: *Pangasius kunyit* Pouyaud *et al.*, 1999.

Site: gills.

Type-locality: Mahakam River at Samarinda (East Kalimantan province, Borneo Island, Indonesia).

Other locality: also found on the same host in the Musi River at Palembang (South Sumatra province, Sumatra Island, Indonesia).

Material studied: 30 individuals fixed and mounted in ammonium picrate-glycerine solution.

Type-material: holotype deposited at the Muséum National d'Histoire Naturelle (Paris): 43HG Tg 187. Paratypes deposited at the Muséum National d'Histoire Naturelle (Paris): 43HG Tg 188; The Natural History Museum (London): n° 2002.3.7.1.

Measurements are given in Table I. Dorsal gripus with blade bend at distal third and poorly developed guard. Large cuneus with medium extension. Slightly curved dorsal transverse bar. Ventral gripus with well marked aperture and poorly developed guard. Thin and long ventral transverse bar with rounded extremities. Heavily sclerotised penis folded back, with large and well developed heel. A complex accessory piece in two parts: the first one is straight, heavily sclerotised and linked by a very short stalk to the basal bulb of the penis, the second one is flared and slightly sclerotised. Non-sclerotised vagina.

Comments

This new species is distinguishable from others *Thaparocleidus* species described on *Pangasius* hosts

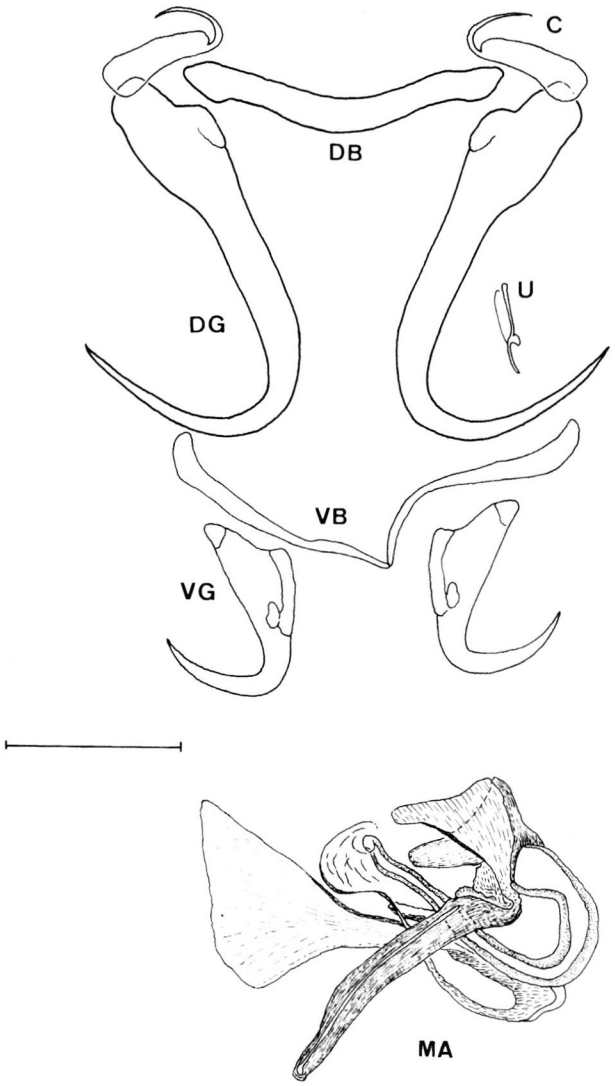

Fig. 4. – *Thaparocleidus culter* n. sp.
C = cuneus; DB = dorsal transverse bar; DG = dorsal gripus; MA = male apparatus; VB = ventral transverse bar; VG = ventral gripus; U = uncinuli. Bar = 30 µm.

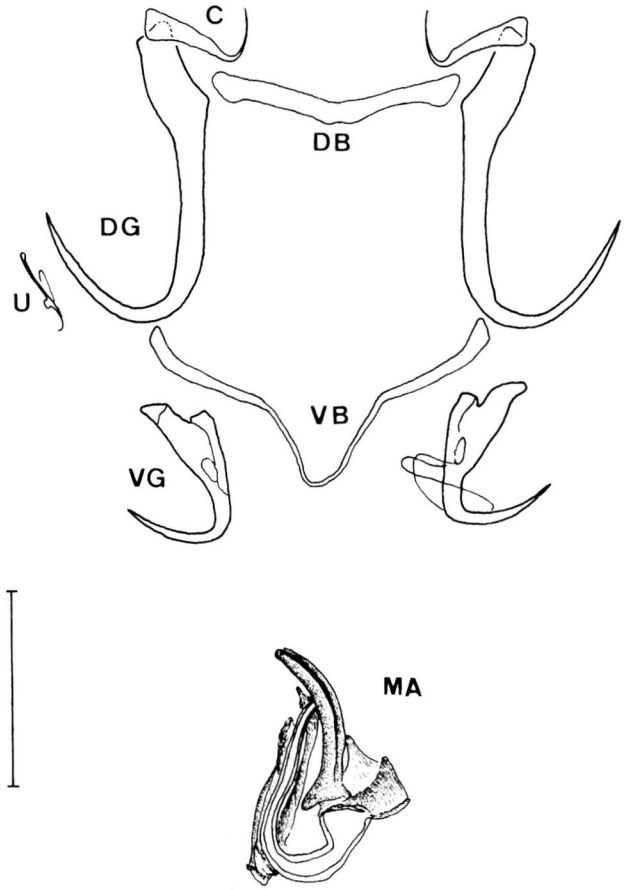

Fig. 5. – *Thaparocleidus culteroides* n. sp.
C = cuneus; DB = dorsal transverse bar; DG = dorsal gripus; MA = male apparatus; VB = ventral transverse bar; VG = ventral gripus; U = uncinuli. Bar = 30 µm.

mainly by the shape of the penis (short, heavily sclerotised and folded back), and of the accessory piece. *Thaparocleidus culter* n. sp. is named for the shape of the accessory piece which resemble a knife blade (culter (Latin) = knife).

THAPAROCLEIDUS CULTEROIDES N. SP.
(Fig. 5, Table I)

Type-host: *Pangasius sabahensis* Gustiano *et al.*, in press.
Site: gills.
Type-locality: Kinabatangan River (Sabah State, Borneo Island, Malaysia).
Material studied: 30 individuals fixed and mounted in ammonium picrate-glycerine solution.

Type-material: holotype deposited at the Muséum National d'Histoire Naturelle (Paris): 44HG Tg 189. Paratypes deposited at the Muséum National d'Histoire Naturelle (Paris): 44HG Tg 190; The Natural History Museum (London): n° 2002.3.7.2.

The morphology of hard parts is similar to *T. culter* n. sp except for the accessory piece linked to the penis which second part is straight (*vs.* flared) and well (*vs.* slightly) sclerotised. Measurements are given in Table I.

Comments

This new species is distinguishable from *T. culter* n. sp., on top of the accessory piece morphology (see above), by the mean length (no overlapping of the ranges) of: the penis (44.9 *vs.* 66.8 µm), the accessory piece (25.6 *vs.* 39.6 µm), the dorsal transverse bar (35.1 *vs.* 51.1 µm), the cuneus (13.1 *vs.* 19.6 µm), the dorsal and ventral gripus total lengths "a" (44 *vs.* 61 µm; 22.5 *vs.* 29.2 µm).
Thaparocleidus culteroides n. sp. is named because it is morphologically closely related to *T. culter* n. sp.

T. phuongi n. sp., described herein, was recorded from all the fish species studied in this paper. The parasitic populations (according to the host species, therefore to the locations) shows similar hard parts morphologies, but we noted some little differences in their measurements (except for those coming from *P. mekongensis* and *P. krempfi*, both from Vietnam). These differences are highlighted in by a PCA performed on all the hard parts measurements (see Fig. 7), but seems to us not sufficient (overlap of measurement ranges) to describe more than sub-species (see below).

THAPAROCLEIDUS PHUONGI PHUONGI N. SUB-SP. (Fig. 6, Table II)

Type-host: *Pangasius mekongensis* Gustiano *et al.*, in press.
Site: gills.
Type-locality: Mekong Delta (Vietnam).
Also found on *Pangasius krempfi* Roberts & Vidthayanon, 1991 at the same location.
Material studied: 60 individuals fixed and mounted in Malmberg solution (30 from *P. mekongensis*, 30 from *P. krempfi*).
Type-material: holotype deposited at the Muséum National d'Histoire Naturelle (Paris): 49HG Tg 199. Paratypes deposited at the Muséum National d'Histoire Naturelle (Paris): 49 HG Tg 200; The Natural History Museum (London): n° 2002.3.7.7.

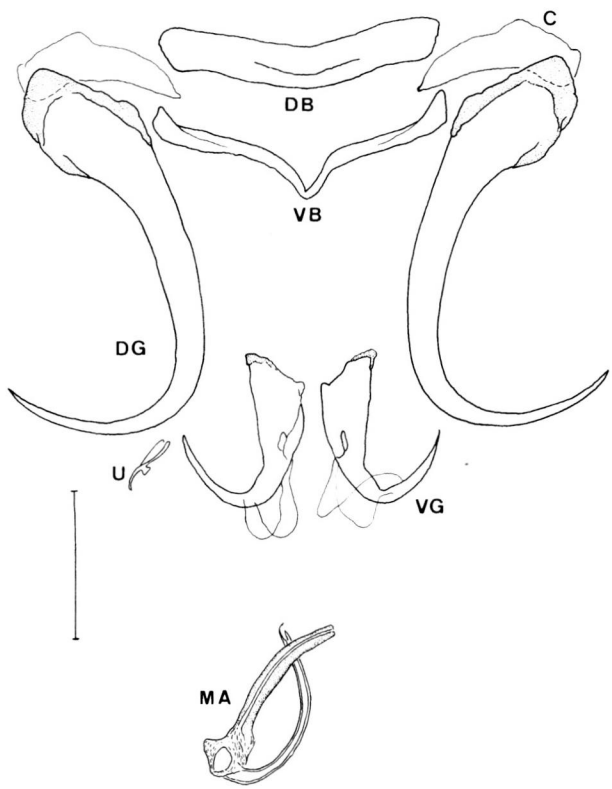

Fig. 6. – *Thaparocleidus phuongi* n. sp.
C = cuneus; DB = dorsal transverse bar; DG = dorsal gripus; MA = male apparatus; VB = ventral transverse bar; VG = ventral gripus; U = uncinuli. Bar = 30 µm.

Dorsal gripus with blade bend at distal third and poorly developed guard. Large cuneus with bubbled protuberance on convex side and very short extension. Slightly curved dorsal transverse bar. Ventral gripus with small aperture and short guard. Thin V-shaped ventral transverse bar. Curved and short penis with ovoid basal bulb and medium heel, slightly curved and short accessory piece with gutter-like depression, linked to the basal bulb of the penis, non-sclerotised vaginal. Measurements are given in Table II.

Comments

The morphology of hard parts is easily distinguishable from all described *Thaparocleidus* from pangasiid host, except from *T. sabanensis* Pariselle *et al.*, 2001a from *Pangasius kinabatanganensis* Roberts & Vidthayanon, 1991, from which it could be distinguished by the length of the heel (2.8 *vs.* 7.5 µm), of the copulatory tube (43.9 *vs.* 56.4 µm) and of the accessory piece (26.7 *vs.* 31.5 µm) (see Fig. 7 and Table II).
Thaparocleidus phuongi phuongi n. sub-sp. is named for Dr Phuong from the Can Tho University (Vietnam) who provides the *Pangasius mekongensis* and *P. krempfi* specimens from the Mekong Delta.

THAPAROCLEIDUS PHUONGI INDONESIENSIS N. SUB-SP.

Type-host: *Pangasius kunyit* Pouyaud *et al.*, 1999.
Site: gills.
Type-locality: Mahakam River at Samarinda (East Kalimantan province, Borneo Island, Indonesia).
Other locality: also found on the same host in the Musi River at Palembang (South Sumatra province, Sumatra Island, Indonesia).
Material studied: 30 individuals fixed and mounted in Malmberg solution.
Type-material: holotype deposited at the Muséum National d'Histoire Naturelle (Paris): 47HG Tg 195. Paratypes deposited at the Muséum National d'Histoire Naturelle (Paris): 47HG Tg 196; The Natural History Museum (London): n° 2002.3.7.5.

Comments

This new subspecies is morphologically identical to the previous one, it is distinguishable from *T. sabanensis* by the length of the heel (3 *vs.* 7.5 µm), of the dorsal transverse bar (67.8 *vs.* 56.3 µm) and of the cuneus (43.4 *vs.* 34.5 µm). All other measurements have a small overlapping of the ranges, but the mean length of all haptoral sclerotised parts are always greater and the mean length of copulatory organs are always smaller. There is not a simple character to distinguish this new

Species	*T. sabanensis*				*T. phuongi indonesiensis*				*T. phuongi malaysiensis*				*T. phuongi phuongi*			
Measurements	Mean	St. D.	Min	Max	Mean	St. D.	Min	Max	Mean	St. D.	Min	Max	Mean	St. D.	Min	Max
Total length	1288.5	151.7	1017.0	1462.0	1110.0	247.5	673.9	1606.9	999.8	518.4	570.1	2232.2	873.2	272.3	481.8	1521.7
Width at level of penis	165.0	37.3	127.9	231.0	184.7	25.5	110.4	220.6	143.6	66.6	72.2	276.4	103.0	22.9	49.4	153.4
Pharynx diameter	93.5	9.8	79.2	107.1	83.2	14.5	54.9	114.2	78.1	32.5	47.8	151.9	57.2	7.9	42.5	77.0
Copulatory tube total length	56.4	3.8	52.2	61.8	51.6	3.4	45.5	60.1	52.9	3.3	47.0	60.1	43.9	2.4	39.9	50.9
Heel	7.5	1.9	4.6	9.4	3	0.6	1.7	3.9	2.7	0.4	1.7	3.5	2.8	0.6	1.8	3.9
Accessory piece total length	31.5	1.0	30.4	33.2	29.9	2.1	26.2	34.9	31.3	1.8	27.3	35.2	26.7	1.4	24.1	30.3
Uncinuli II total length	17.7	1.0	16.2	19.1	15.0	0.9	13.1	17.3	15.4	0.9	13.9	18.5	15.1	0.9	12.1	17.8
Other uncinuli total length	16.5	1.9	12.4	19.6	12.7	1.3	9.5	15.7	12.9	1.2	9.5	15.5	12.3	1.0	9.8	14.6
Dorsal transverse bar length	56.3	1.6	53.9	58.0	67.8	3.8	61.4	76.0	55.0	3.3	46.2	58.7	57.1	2.6	51.4	63.5
Dorsal transverse bar width	8.8	0.7	7.6	9.4	9.9	0.8	8.4	11.6	9.3	1.0	7.3	11.5	8.2	1.1	5.6	10.9
Cuneus length	34.5	0.8	33.5	35.5	43.4	1.8	39.0	48.0	31.3	2.4	26.1	36.3	36.4	2.3	29.9	41.0
Cuneus extension length	2.9	1.3	1.5	5.6	2.7	1.2	1.2	7.1	3.9	1.4	1.6	9.4	2.3	0.9	0.8	5.9
Cuneus maximum width	9.7	0.8	8.9	11.3	12.4	1.2	9.4	15.2	10.2	0.8	7.6	12.0	9.6	0.8	7.9	11.5
Dorsal gripus a	77.2	3.1	72.2	82.1	85.2	3.4	78.1	91.8	70.9	4.5	58.1	77.0	76.8	3.4	67.9	83.0
Dorsal gripus b	66.0	2.6	61.4	70.4	73.6	3.4	66.8	81.3	60.6	4.0	49.1	66.5	66.6	3.2	58.0	73.2
Dorsal gripus c	2.9	0.5	2.2	3.9	2.4	0.6	1.3	4.0	2.3	0.6	1.4	4.9	1.9	0.5	0.8	3.0
Dorsal gripus d	15.5	1.1	14.3	17.5	18.6	1.5	15.7	21.7	15.9	1.1	13.4	17.8	16.4	1.4	12.8	19.8
Dorsal gripus e	34.0	1.0	32.3	35.9	39.7	3.7	31.7	47.2	32.4	2.5	26.2	37.8	29.5	2.3	23.5	34.8
One branch of ventral bar length	36.5	1.7	33.8	39.4	42.7	1.6	38.6	47.5	35.8	2.3	29.5	40.2	38.4	1.8	34.0	42.3
Ventral bar maximum width	4.5	0.6	4.0	5.6	4.9	0.4	4.1	6.1	4.3	0.5	3.3	5.4	4.6	0.5	3.3	5.6
Ventral gripus a	33.1	0.7	32.2	34.4	35.3	1.4	31.9	38.0	31.4	1.4	28.9	33.5	31.5	1.1	28.1	34.7
Ventral gripus b	27.4	0.8	26.1	28.4	29.8	1.3	27.3	32.6	26.9	1.4	24.3	29.5	27.3	1.1	24.4	30.0
Ventral gripus c	2.0	0.7	1.2	3.2	1.3	0.3	0.8	2.4	1.2	0.3	0.6	1.8	1.2	0.3	0.6	2.6
Ventral gripus d	9.7	0.7	8.5	10.8	11.0	0.8	9.3	12.8	9.2	0.9	7.0	10.8	9.1	0.8	6.8	11.3
Ventral gripus e	18.9	1.0	17.6	20.8	20.9	1.0	19.0	22.9	19.0	1.0	16.0	20.5	19.0	0.6	17.7	20.5
Ventral gripus aperture length	3.7	0.5	2.8	4.3	4.6	0.7	2.5	6.3	4.1	0.7	2.4	5.2	4.2	0.8	2.8	6.4
Ventral gripus aperture width	1.5	0.3	1.1	2.1	1.8	0.4	0.7	2.8	1.7	0.5	0.5	3.1	1.9	0.5	0.9	3.7

Table II. – Measurements from *T. sabanensis* n. sp. (after Pariselle *et al.*, 2001a); *T. phuongi phuongi* n. sub-sp.; *T. phuongi indonesiensis* n. sub-sp. and *T. phuongi malaysiensis* n. sub-sp

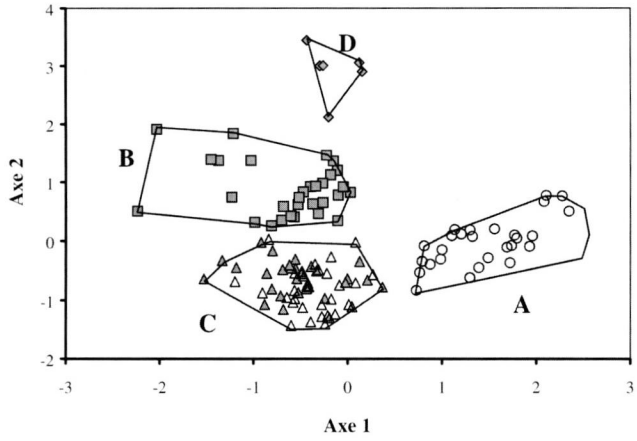

Fig. 7. – PCA performed on the all the measurements of the hard parts of parasites from: **A** *P. kunyit* (*T. phuongi indonesiensis* n. sub-sp.), **B** *P. sababensis* (*T. phuongi malaysiensis* n. sub-sp.), **C** *P. mekongensis* and *P. krempfi* from Vietnam (*T. phuongi phuongi* n. sub-sp.), **D** *P. kinabatanganensis* from Sabah (*T. sabanensis*).

sub-species from *T. phuongi phuongi*. Knowing that the PCA analysis shows clearly (Fig. 7) that these sub-species are distinct based on reliable data (specimen preparations and measurment done by the same person (the first author) using the same equipment (microscope, digitiser, etc)), we consider that *Thaparocleidus phuongi indonesiensis* n. sub-sp. is a valid subspecies, named after the location (Indonesia).

THAPAROCLEIDUS PHUONGI MALAYSIENSIS N. SP. N. SUB-SP.

Type-host: *Pangasius sababensis* Gustiano *et al.*, in press.
Site: gills.
Type-locality: Kinabatangan River (Sabah State, Borneo Island, Malaysia).
Material studied: 30 individuals fixed and mounted in Malmberg solution.
Type-material: holotype deposited at the Muséum National d'Histoire Naturelle (Paris): 48HG Tg 197. Paratypes deposited at the Muséum National d'Histoire Naturelle (Paris): 48HG Tg 198; The Natural History Museum (London): n° 2002.3.7.6.

Comments

This new subspecies is morphologically identical to the previous ones, it is distinguishable from *T. sabanensis* by the length of the heel (2.7 *vs.* 7.5 µm); from *T. phuongi indonesiensis* n. subsp. by the length (no overlapping of the ranges) of the dorsal transverse bar (55 *vs.* 67.8 µm), of the cuneus (31.3 *vs.* 43.4 µm), of the dorsal gripus "a" and "b" (70.9 *vs.* 85.2 µm; 60.6 *vs.* 73.6 µm). There is not a simple character to distinguish this new sub-species from *T. phuongi phuongi*. Knowing that the PCA analysis shows clearly (Fig. 7) that these subspecies are distinct based on reliable data (specimen preparations and measurment done by the same person (the first author) using the same equipment (microscope, digitiser, etc)), we consider that *Thaparocleidus phuongi malaysiensis* n. subsp. is a valid subspecies, named after the location (Malaysia).

DISCUSSION

T. vietnamensis was recovered from *P. mekongensis* only on specimens from cage culture, as indicated previously (see Pariselle *et al.*, 2002): "The presence of *T. vietnamensis* n. sp. on four different host species (*P. bocourti*, *P. hypophthalmus*, *P. kunyit* Pouyaud *et al.*, 2000 [syn. *P. mekongensis*] and *P. conchophilus* Roberts & Vidthayanon, 1991) sampled in aquaculture facilities on the Mekong Delta, may be the result of lateral transfer or of natural occurrence, as all these host species originate from this river."
T. culter n. sp./*T. culteroides* n. sp., *T. humerus* n. sp./*T. meburus* n. sp., and the three subspecies of *T. phuongi* n. sp. are morphologically closely related and are found on closely related host species (initially *P. mekongensis* and *P. sababensis* where recorded as populations of *P. kunyit* new species described by Pouyaud *et al.* (1999)). This observation leads us to think that the evolution in these monogenean parasites is linked to that of the hosts: the isolation of host population isolates the parasites, then both fish and Monogenea have a genetic drift, ending in co-speciation, as revealed by the morphological proximities of both hosts and parasites.
The presence of *T. phuongi phuongi* n. sub-sp., both on *P. krempfi* and *P. mekongensis*, which are not closely related (see Pouyaud *et al.*, 2000[1]), but living in the same area (Mekong Delta) should be the result of a lateral transfer probably from *P. mekongensis* to *P. krempfi*, as *T. phuongi* n. sp. is also described in other locations on host closely related to *P. mekongensis*.

CONCLUSION

The occurrence of host switching had both been invoked for natural ancient parasite transfer (see Choudhury & Dick, 1998; Carney & Dick, 2000) as it was probably the case for *T. phuongi phuongi*, and reported or experienced for recent man-made introductions in the wild or in artificial conditions (e.g. in aquaculture) (Silan *et al.*, 1985; Bauer, 1991; Pojmanska & Chabros, 1993; Ernst & Whittington, 2001)

[1] In this paper *P. kunyit* is indicated as sp1.

as it may be the case for *T. vietnamensis*. In the latter case, the high susceptibily of hosts to new tranferred parasites is often highlited as a potential danger, and should therefore be taken into account for the developpement of Pangasiid aquaculture.

The present five new species bring the number of *Thaparocleidus* species described on 14 species of pangasiids (*P. bocourti*, *P. djambal*, *P. gigas*, *P. humeralis*, *P. hypophthalmus*, *P. kinabatanganensis*, *P. krempfi*, *P. kunyit*, *P. lithostoma*, *P. mekongensis*, *P. nieuwenhuisii*, *P. pangasius*, *P. rheophilus* and *P. sabahensis*) to 22.

The diversity of monogenean species on the 15 studied host species is always variable from zero to six.

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REFERENCES

Bauer O.N. Spread of parasites and diseases of aquatic organisms by acclimatization: A short review. *Journal of Fish Biology*, 1991, *39*, 679-686.

Carney J.P. & Dick T.A. The historical ecology of yellow perch (*Perca flavescens* [Mitchill]) and their parasites. *Journal of Biogeography*, 2000, *27*, 1337-1347.

Choudhury A. & Dick T.A. Systematics of the Deropristiidae Cable & Hunninen, 1942 (Trematoda) and biogeographical associations with sturgeons (Osteichthyes: Acipenseridae). *Systematic Parasitology*, 1998, *41*, 21-39.

Ernst I. & Whittington I. Experimental susceptibility of some reef fish species to *Benedenia lutjani* (Monogenea: Capsalidae), a parasite of *Lutjanus carponotatus* (Pisces: Lutjanidae). *Parasitology Research*, 2001, *87*, 345-348.

Euzet L. & Prost M. Report of the meeting on Monogenea: problems of systematics, biology and ecology. *In:* Slusarski W. (Eds). *Review of advances in parasitology*. Warsaw: P.W.N. Polish Scientific Publishers, 1981, pp. 1003-1004.

Gussev A.V. *In:* Bychovskaya-Pavlovskaya, I.E. *et al.* (Eds) [*Key to parasites of freshwater fish of the USSR.*] Moscow-Leningrad: Academiya Nauk SSSR, 1962, 919 pp. (In Russian: English translation IPST, Ser. No. 1136, Jerusalem, 1964).

Gustiano R., Teugels G.G. & Pouyaud L. Revision of the *Pangasius kunyit* catfish complex, with description of two new species from Southeast Asia (Siluriformes; Pangasiidae). *Journal of Natural History*, in press.

Lim L.H.S. *Silurodiscoides* Gussev, 1961 (Monogenea: Ancyrocephalidae) from *Pangasius sutchi* Fowler, 1931 (Pangasiidae) cultured in Peninsular Malaysia. *Raffles Bulletin of Zoology*, 1990, *38*, 55-63.

Lim L.H.S. *Thaparocleidus* Jain, 1952, the senior synonym of *Silurodiscoides* Gussev, 1976 (Monogenea: Ancyrodiscoidinae). *Systematic Parasitology*, 1996, *35*, 207-215.

Lim L.H.S., Timofeeva T.A. & Gibson D.I. Dactylogyridean monogeneans of the siluriform fishes of the old world. *Systematic Parasitology*, 2001, *50*, 159-197.

Malmberg G. [On the occurrence of *Gyrodactylus* on Swedish fishes.] *Skrifterutgivna av Sodra Sveriges Fiskeriforening*, (1956), 1957, pp. 19-76 (in Swedish, with description of species and a summary in English).

N'Douba V., Lambert A. & Euzet L. Gill parasites of the genus *Quadriacanthus* Paperna, 1961 from *Heterobranchus longifilis* and *H. isopterus* with description of seven new species from Côte d'Ivoire, West Africa. *Systematic Parasitology*, 1999, *44*, 105-118.

Pariselle A. & Euzet L. Gill parasites of the genus *Cichlidogyrus* Paperna, 1960 (Monogenea, Ancyrocephalidae) from *Tilapia guineensis* (Bleeker, 1862), with descriptions of six new species. *Systematic Parasitology*, 1995, *30*, 187-198.

Pariselle A., Lim L.H.S. & Lambert A. Monogeneans from Pangasiidae (Siluriformes) in Southeast Asia: I. Five new species of *Thaparocleidus* Jain, 1952 (Ancylodiscoididae) from *Pangasius pangasius*, *P. kinabatanganensis*, *P. rheophilus* and *P. nieuwenhuisii*. *Parasite*, 2001a, *8*, 127-135.

Pariselle A., Lim L.H.S. & Lambert A. Monogeneans from Pangasiidae (Siluriformes) in Southeast Asia: II. Four new species of *Thaparocleidus* Jain, 1952 (Ancylodiscoidinae) from *Pangasius humeralis*. *Parasite*, 2001b, *8*, 317-324.

Pariselle A., Lim L.H.S. & Lambert A. Monogeneans from Pangasiidae (Siluriformes) in Southeast Asia: III. Five new species of *Thaparocleidus* Jain, 1952 (Ancylodiscoidinae) from *Pangasius bocourti*, *P. djambal* and *P. hypophthalmus*. *Parasite*, 2002, *9*, 207-217.

Pouyaud L., Teugels G.G. & Legendre M. Description of a new pangasiid catfish from South-East Asia (Siluriformes, Pangasiidae). *Cybium*, 1999, *23*, 247-258.

Pojmanska T. & Chabros M. Parasites of common carp and three introduced cyprinid fish in pond culture. *Acta Parasitologica*, 1993, *38*, 101-108.

Pouyaud L., Teugels G.G., Gustiano R. & Legendre M. Contribution to the phylogeny of pangasiid catfishes based on allozymes and mitochondrial DNA. *Journal of Fish Biology*, 2000, *56*, 1509-1538.

Silan P., Cabral P. & Maillard C. Enlargement of the host range of *Polylabris tubicirrus* (Monogenea, Polyopisthocotylea) under fish-farming conditions. *Aquaculture*, 1985, *47*, 267-270.

Tripathi Y.R. Monogenetic trematodes from fishes in India. *Indian Journal of Helminthology*, 1957, *9*, 1-149.

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