

Digenean Fauna in Marine Fishes from Taiwanese Waters with the Description of a New Species, *Lecithochirium tetraorchis* sp. nov.

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Hsiu-Hui Shih, Wei Liu, and Zhao-Zhi Qiu (2004) Digenean fauna in marine fishes from Taiwanese waters with the description of a new species, *Lecithochirium tetraorchis* sp. nov. *Zoological Studies* 43(4): 671-676. In total, 624 marine fishes (mostly bony fishes) of 37 species belonging to 29 families harvested from 4 fishing zones of Taiwanese waters were examined for their digenean fauna over a 5-year period (1998~2003). Digeneans were recovered from 17 fish species among the 37 species examined. The digenean prevalence by fish species was 45.9% (17/37) in this study. Of 28 fish species taken from 3 investigated fishing zones, located on important fishing grounds of the Taiwan Strait, a similar prevalence of 46.4% (13/28) was also shown in fish species. Totally, 16 species of digeneans belonging to 11 genera and 8 families were collected and identified. Species of the family Hemiuridae were the most-common digeneans found, with 7 species of this family being identified. Within this family, species of the genus *Lecithochirium* were recorded 8 times. *Suggrundus longirostris* Shao et Chen, 1987 is a new host record for *L. magnaporum* Manter, 1940. One new species, *L. tetraorchis* sp. nov., parasitizing *Sebastiscus marmoratus* Curvier, 1829, is described in this study. <http://www.sinica.edu.tw/zool/zoolstud/43.4/671.pdf>

Key words: Digenean fauna, Marine fishes, New species, *Lecithochirium*.

Taiwan is located in the Northwest Pacific Ocean. It is surrounded by the East China Sea in the north, the Taiwan Strait in the west, and the South China Sea in the south. The Taiwan Strait is not only an important fishing ground but also serves as a pathway for migratory fishes between the 2 waters of the East and South China Seas (Hsieh and Chiu 2002). Based on records of fishes in Taiwan, 2028 species belonging to 237 families have been described (Shen 1993). It is well known that marine fishes may play roles of intermediate or definitive hosts of a number of helminthic parasites. However, the parasitic fauna of marine fishes around Taiwanese waters has seldom been studied.

In the 1960s, anisakid nematodes such as *Anisakis*, *Contracaecum*, *Raphidascaris*, and their larval stages were reported from 40 Taiwanese fish species (Myers and Kuntz 1967). Moreover, 17 species of adult nematodes were found in 13

genera of 9 families of marine fish collected from the southern Taiwan Strait (Luo 2001a, b). Among those species, 7 were newly described, and 5 genera were newly recorded in the South China Sea. A heavily infected rabbitfish (*Siganus fuscescens*) with another anisakid (*Hysterothylacium aduncum*) were also found in Taiwanese waters (Shih and Jeng 2002). Adults and 4th-stage larvae were collected from the gastrointestinal tract of those fish. In addition, 3rd-stage larvae were found within the body coelom of a chaetognath (*Sagitta* sp.). The life cycle of *H. aduncum* involving host species of marine fishes and the chaetognath was first postulated based on material from Taiwanese waters (Shih and Jeng 2002). Among the trematodes in Taiwanese marine fish, only 3 digeneans belonging to the family Hemiuridae have been recorded. However, these parasites were not identified from 67 economically important marine fish species collected from the southern Taiwan Strait (Yau 1998).

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This study was designed to determine the digenean fauna from the abundant marine fish species in Taiwanese waters. From 1998 to 2003, 37 species of 29 families of marine fishes were examined, and 16 species of adult digeneans belonging to 11 genera of 8 families were collected and identified. In addition, a new species is also described in this report.

MATERIALS AND METHODS

From Apr. 1998 to May 2003, marine fishes of 34 species belonging to 27 families were purchased from fishermen in Ilan, Pingtung, and Penghu, Taiwan. The fishing regions were carefully investigated and designated as IL, offshore from Ilan, northeastern Taiwan ($24^{\circ}94'N$, $122^{\circ}15'E$); PH, in the southwestern region of the Penghu Archipelago in the central Taiwan Strait ($23^{\circ}40'N$, $119^{\circ}30'E$); and PT, offshore from Pingtung, southwestern Taiwan ($22^{\circ}31'N$, $120^{\circ}22'E$). Three fish species of 3 families from the Taoyuan region, northwestern Taiwan, designated TY ($25^{\circ}08'N$, $120^{\circ}90'E$), were collected during research cruises by Dr. I. C. Lee (Institute of Fisheries Science, National Taiwan University). These fish were transported to the laboratory and identified following diagnostic characteristics described by Shen (1993). After opening their abdomen, flukes were washed out and collected from the stomach and intestines with normal saline (0.9% NaCl). Flukes were repeatedly washed to remove any mucus or debris from their surfaces.

Flukes were fixed in 5% formalin, flattened by repression and stained with Semichon's carmine. These specimens were then dehydrated in an alcohol gradient series, and mounted on Permount balsam (Fisher Scientific, NJ, USA). Taxonomic identifications of the Digenea were based on Yamaguti (1971). Illustrations of a new species identified were made with the aid of a drawing tube. Except those for eggs in micrometers, all other measurements are given in millimeters.

RESULTS

Digenean fauna of marine fishes in Taiwanese waters

Thirty-seven species belonging to 29 families of marine fishes taken from Taiwanese waters were examined for digenean fauna. Among them,

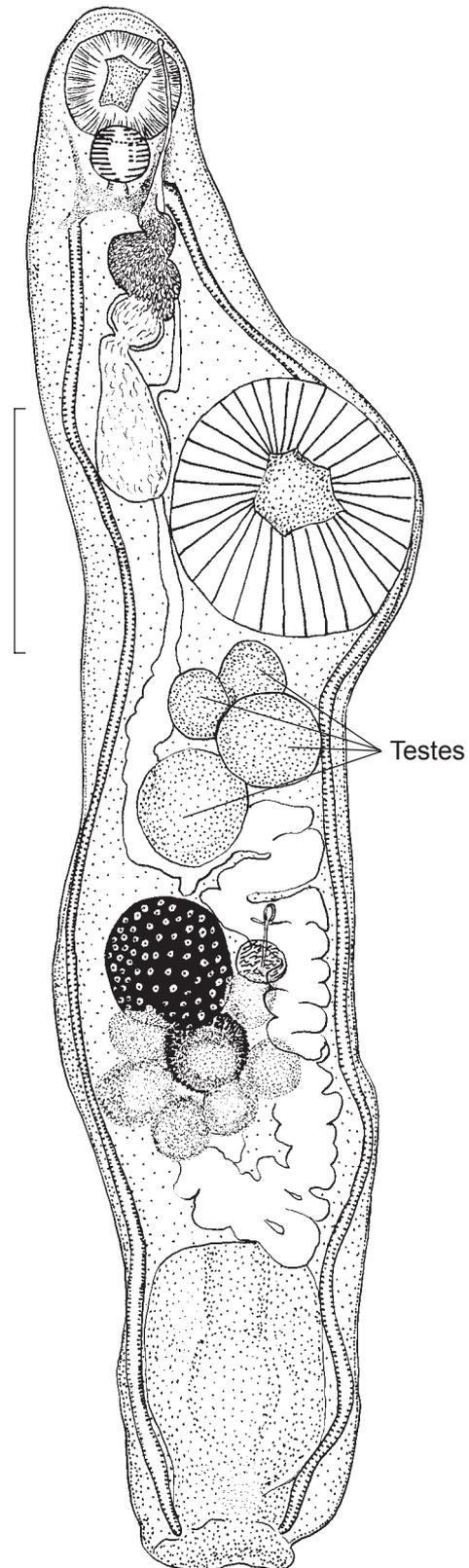


Fig. 1. Whole-mount holotype of *Lecithochirium tetraorchis* sp. nov. Scale bar = 0.3 mm.

only 1 species of 1 family (Proscylliidae) belonging to the Chondrichthyes was recorded, with the remaining 36 species of 28 families belonging to the Osteichthyes. Digeneans were collected from 17 bony fish species, but none from the chondrichthyes (Table 1). In addition, the digenean prevalence by fish species was 45.9% (17/37).

Sixteen species of digeneans belonging to 11 genera and 8 families were collected and identified (Table 2). Species of the family Hemiuridae were the most-common ones with 7 species identified. Within this family, species of the genera *Lecithochirium* were recorded 8 times.

Lecithochirium fusiformis Luhe, 1901 and *L. trichiuri* Gu et Shen, 1981, were collected from 3 and 2 fish hosts, respectively. *Suggrundus longirostris* is a new host record for *L. magnaporum* Manter, 1940. A new species (*L. tetraorchis* sp. nov.) was identified and is described herein.

Table 3 shows the geographical distribution of the fish and digenean species. Among fish species collected from 3 sampling sites (PH, PT, and TY) of the Taiwan Strait, 46.4% (13/28) were infected with 1~13 digenean species.

Table 1. Fish species and the number of individuals captured from 4 areas around Taiwan and the digenean species recorded therein

| Host species | No. of hosts | Capture site | No. of digenean species | Host species | No. of hosts | Capture site | No. of digenean species |
|--|--------------|--------------|-------------------------|--------------------------------|--------------|--------------|-------------------------|
| Class Chondrichthyes | | | | <i>Leiognathus lineolatus</i> | 337 | PH | 1 |
| Family Proscylliidae | | | | <i>Secutor ruconius</i> | 15 | PH | 0 |
| <i>Proscyllium habereri</i> | 1 | IL | 0 | Family Lutjanidae | | | |
| Class Osteichthyes | | | | <i>Lutjanus gibbus</i> | 1 | PT | 0 |
| Family Acanthuridae | | | | Family Molidae | | | |
| <i>Naso brachycentron</i> | 2 | PT | 0 | <i>Mola mola</i> | 1 | PT | 1 |
| <i>Prionurus scalprus</i> | 2 | IL | 0 | Family Myctophidae | | | |
| Family Aplodactylidae | | | | <i>Diaphus</i> sp. | 13 | PT | 0 |
| <i>Goniistius zonatus</i> | 2 | IL | 0 | Family Ophidiidae | | | |
| Family Apogonidae | | | | <i>Neobythites sivicola</i> | 2 | PT | 0 |
| <i>Apogon cookii</i> | 2 | PH | 1 | Family Oplegnathidae | | | |
| <i>Archamia fucata</i> | 4 | PH | 0 | <i>Opleganthus punctatus</i> | 2 | IL | 0 |
| Family Ariidae | | | | Family Pempheridae | | | |
| <i>Arius maculatus</i> | 6 | TY | 0 | <i>Pempheris oualensis</i> | 2 | PH | 0 |
| Family Belonidae | | | | Family Platycephalidae | | | |
| <i>Ablennes hians</i> | 4 | PH | 1 | <i>Suggrundus longirostris</i> | 2 | IL | 1 |
| Family Caesionidae | | | | Family Pomacentridae | | | |
| <i>Pterocaesio digramma</i> | 49 | PH | 0 | <i>Chromis fumea</i> | 3 | PH | 0 |
| Family Carangidae | | | | Family Priacanthidae | | | |
| <i>Scomberoides commersonianus</i> | 2 | TY | 1 | <i>Cookeolus boops</i> | 2 | IL | 0 |
| <i>S. tol</i> | 1 | PH | 0 | Family Scombridae | | | |
| <i>Selaroides leptolepis</i> | 2 | PH | 0 | <i>Euthynnus affinis</i> | 1 | PT | 1 |
| <i>Seriola dumerili</i> | 5 | IL | 1 | <i>Thunnus albacares</i> | 1 | PT | 1 |
| Family Chirocentridae | | | | Family Scorpaenidae | | | |
| <i>Chirocentrus dorab</i> | 1 | PH | 1 | <i>Sebastiscus marmoratus</i> | 1 | IL | 1 |
| Family Chlorophthalmidae | | | | Family Serranidae | | | |
| <i>Chlorophthalmus nigromarginatus</i> ¹⁰ | | PT | 0 | <i>Cephalopholis boenack</i> | 7 | PT | 0 |
| Family Coryphaenidae | | | | Family Siganidae | | | |
| <i>Coryphaena hippurus</i> | 1 | PT | 1 | <i>Siganus fuscescens</i> | 120 | IL, PH | 2 |
| Family Megalopidae | | | | <i>S. spinus</i> | 2 | IL | 1 |
| <i>Megalops cyprinoides</i> | 4 | TY | 1 | Family Trichiuridae | | | |
| Family Latilinae | | | | <i>Trichiurus lepturus</i> | 10 | IL, PT | 1 |
| <i>Branchiostegus auratus</i> | 1 | IL | 2 | Family Triglidae | | | |
| Family Leiognathidae | | | | <i>Pterygotrigla hemistica</i> | 3 | PT | 0 |

Systematic account of *Lecithochirium tetraorchis* Shih et Qiu, sp. nov.

Holotype: Adult (Fig. 1). Taiwan: offshore from Ilan, northeastern Taiwan, collected by H. H. Shih, 10 Apr., 1998, deposited in the Department of Zoology, National Taiwan University.

Diagnosis: This new species differs from all known species by the presence of 4 testes.

Description: Body elongate with tail, 1.959

long x 0.359 wide at acetabular level. Oral sucker subterminal, cup-shaped, 0.141 x 0.164. Pharynx well developed, 0.086 x 0.078. Ceca not extending into tail. Acetabulum prominent, 0.320 x 0.313, much larger than oral sucker, near anterior extremity. Ratio of these 2 suckers 1: 2. Testes 4, diagonal 2 pairs, immediately postacetabular, anterior pair 0.070 x 0.078 and 0.125 x 0.117, posterior pair larger, 0.117 x 0.078 and 0.056 x 0.148. Vesicula seminalis anterior to acetabulum, elon-

Table 2. Digeneans collected and identified from marine fishes from Taiwanese waters

| Digeneans | Hosts |
|--|--|
| Family Accacoeliidae <i>Odhnerium</i> sp. | <i>Mola mola</i> |
| Family Bivesiculidae <i>Bivescula lutiani</i> Gu et Shen, 1979 | <i>Apogon cookii</i> |
| Family Bucephalidae <i>Bucephalopsis ablennus</i> Gu et Shen, 1976 <i>Prosorhynchus facilis</i> Ozaki, 1924 | <i>Ablennes hians</i> <i>Seriola dumerili</i> |
| Family Gyliauchenidae <i>Gyliauchen oligoglandulosus</i> Gu et Shen, 1979 | <i>Siganus fuscescens</i> |
| Family Hemiuridae <i>Dinurus longissimus</i> Looss, 1907 <i>Lecithochirium fusiforms</i> Luhe, 1901 <i>L. fusiforms</i> Luhe, 1901 <i>L. fusiforms</i> Luhe, 1901 <i>L. magnaporcum</i> Manter, 1940 <i>L. priacanthi</i> Yamaguti, 1953 <i>L. tetraorchis</i> sp. nov. <i>L. trichiuri</i> Gu et Shen, 1981 <i>L. trichiuri</i> Gu et Shen, 1981 <i>Parahemiurus collichthydis</i> Li, 1986 | <i>Coryphaena hippurus</i> <i>Branchiostegus auratus</i> <i>Euthynnus affinis</i> <i>Siganus spinus</i> <i>Suggrundus longirostris</i> ^a <i>Megalops cyprinoides</i> <i>Sebastiscus marmoratus</i> <i>Scomberoides commersonianus</i> <i>Trichiurus lepturus</i> <i>Branchiostegus auratus</i> |
| Family Lobatovitelliovariidae <i>Lobatovitelliovarium fusiforme</i> Yamaguti, 1965 | <i>Leiognathus lineolatus</i> |
| Family Opeceolidae <i>Opeceolus ditrematis</i> Yamaguti, 1942 <i>O. lateolabracis</i> Yamaguti, 1958 | <i>Siganus fuscescens</i> <i>Chirocentrus dorab</i> |
| Family Syncoeliidae <i>Syncoelium cypseluri</i> Yamaguti, 1970 | <i>Thunnus albacares</i> |

^a New host record.

Table 3. Summary of total fish species examined and digeneans found from each capture site

| Capture site | Location of fishing region | Total fish species examined | Total digenean species found |
|--------------|----------------------------|-----------------------------|------------------------------|
| IL | East China Sea | 12 | 9 |
| PH | Central Taiwan Strait | 12 | 6 |
| PT | Southeastern Taiwan Strait | 13 | 5 |
| TY | Northeastern Taiwan Strait | 3 | 2 |

gate, thick-walled, constricted, 0.031 x 0.031; outer one, 0.116 x 0.051. Pars prostatica present, 0.041 x 0.045. Cirrus pouch present with 2 chambers, the outer 0.219 x 0.094, the inner 0.063 x 0.055. Ovary rounded, 0.156 x 0.156, posttesticular in right body. Mehlis's gland 0.117 x 0.117. Laurer's canal present, 0.031 long. Vitellaria 7, compact, rounded, postovarian, each 0.211 x 0.273. Uterus descending and then ascending, 0.375 from the posterior extremity. Eggs numerous, 168~178 x 99~119 μ m. Genital pore ventral to oral sucker near its anterior margin. Tail 0.352 x 0.289. Parasitic in stomach of the marine fish, *Sebastiscus marmoratus* Curvier, 1929.

Etymology: The name is derived from the Greek "tetra" (=4) and "orchis" (=testis).

DISCUSSION

It is well known that most components of the world's vertebrate and invertebrate fauna are parasitized, and thus monitoring the helminth parasites of these hosts can contribute information to many aspects. First, parasites can provide a new dimension to our understanding of ecological interactions, patterns of distribution, and the complex history of many geographic regions and biotas (Hoberg 1997). Second, parasites constitute "biodiversity probes" that can be directly applied to questions of contemporary diversity and the historical development of community structure (Brooks et al. 1992). Third, parasites can serve as indicators of both acute and chronic conditions, those resulting from either anthropogenic or natural events (Overstreet 1997).

Research on fish parasite fauna has increasingly provided such contributions. For example, the unique nature of the constituents of biodiversity in tropical freshwater communities has been highlighted based on historical biogeographic and ecological analyses of potamotrygonid parasites (Brooke et al. 1992). The western mosquitofish is being used as a good environmental sentinel, and its level of health was determined in terms of species richness of parasites and of being free from pathogenic parasites known to be associated with stress (Overstreet et al. 1996). Furthermore, fish parasites have been used for almost a century as biological indicators, markers, or tags to provide information on various aspects of host biology including population biology, migration, diet, and phylogenetics (Williams et al. 1992).

The high diversity of the digenean fauna is

first revealed herein from marine fish from Taiwanese waters. Totally, 16 digenean species belonging to 11 genera and 8 families were collected and identified, among which 7 species belong to the family Hemiuridae. The Hemiuridae comprised the most-common digeneans found inside the digestive tract of marine fish, which coincides with previously reported findings (Marianne 1990). In addition, the most-common genus of this family is *Lecithochirium* as found in the present study. Their host specificity is not strict since 1 species (*L. fusiformis* Luhe, 1901) was harvested from 3 different fish species, and another one (*L. trichiuri* Gu et Shen, 1981) occurred in 2 species. Total digenean species richness was higher in the Taiwan Strait than in the open ocean area (13 in the Taiwan Strait vs. 9 at IL). Fish digenean fauna and the infection status presented herein is believed to be useful for further revelations of the community structure of marine fishes and fish host biology in Taiwanese waters.

The generic diagnosis of the *Lecithochirium* genus concerns the male gonad, host, and habitat: the testes are symmetrical, immediately postacetabular, and species are parasitic in the stomach of marine fishes (Yamaguti 1971). All species of this genus described including 4 species reported herein possess 1 pair of testes. However, the fluke harvested from the stomach of the marine fish, *S. marmoratus*, and diagnosed to belong to this genus but having 2 pair of testes was therefore identified as a new species, *L. tetraorchis* sp. nov.

Because fish may play roles as either intermediate or definitive hosts of digeneans, fluke infections may cause fish diseases which can directly damage the host or can indirectly affect human health if raw or poorly cooked fish which contains digenean larvae is consumed. All digeneans reported here were in the adult stage and were parasitic in the fish gut. As such, they should not cause any problems for public health. Furthermore, the 4 sampled sites studied herein are also major cage farm regions in Taiwan. The high prevalence of digenean infections and the diversity of its fauna revealed from this study may imply a dormant threat to the cage farming industry in Taiwanese waters, and this should be carefully and continually monitored.

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