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MONOGENEAN PARASITES OF MEXICAN FRESHWATER FISHES. I. INTRODUCTORY REMARKS, WITH AN ACCOUNT OF THE PARASITE GENUS *DACTYLOGYRUS* DIESING, 1850*

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ABSTRACT

This study represents the first research performed on the monogenetic trematodes of the freshwater fishes of Mexico, and is the first of a proposed series of studies on these parasites.

Several new species of Monogenea were recovered from mexican freshwater fishes housed in the fish collection of the University of Michigan. The majority of these were minnows (family Cyprinidae), found to be harboring species of the monogean genus *Dactylogyrus*.

The cyprinid faunas of Canada, the United States and Mexico are briefly outlined.

An account of the anatomy and systematics of *Dactylogyrus* is furnished. Included is a recommended system of anatomical terms useful for descriptions of monogenetic trematodes.

The specificity of various Monogenea, for certain hosts is discussed. It is shown that a high degree of specificity exists between *Dactylogyrus* and cyprinids.

A list of mexican freshwater fishes (from the University of Michigan collection) harboring monogeneans is given, alog with the genera of parasites recovered.

RESUMEN

Este estudio representa la primera investigación efectuada sobre tremátodos monogéneos de peces de aguas dulces de México y es la primera de una serie de estudios propuesta, sobre estos parásitos.

Varias especies nuevas de monogéneos fueron obtenidas de peces de aguas dulces de México, guardados en la colección de peces de la Universidad de Michigan. La mayoría de éstos, fueron peces pequeños (Familia Cyprinidae) encontrándose que son especies portadoras de monogéneos del género *Dactylogyrus*.

Se esbozan brevemente las faunas de ciprinidos de Canadá, Estados Unidos y México.

Se proporciona un informe de la anatomía y sistemática de *Dactylogyrus*.

Se incluye un sistema recomendable de términos anatómicos útiles para las descripciones de los tremátodos monogéneos.

La especificidad de varios Monogenea para ciertos hospedadores es considerada. Se demuestra que existe un alto grado de especificidad entre *Dactylogyrus* y los ciprínidos.

Se aporta una lista de peces mexicanos de aguas dulces (de la colección de la Universidad de Michigan) portadores de Monogéneos, junto con los géneros de los parásitos obtenidos.

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The monogenetic trematodes of marine fishes of Mexico and adjacent areas have received a great deal of attention in recent years. Most of this research has been performed by Dr. Eduardo Caballero y C. and Dr. Margarita Bravo-Hollis, working either in collaboration or separately.

In the case of monogenean parasites of Mexican freshwater fishes, however, the situation is quite different. As nearly as we are able to determine, the monogenean literature does not contain a single account of a Mexican freshwater gill trematode.

During the summer of 1967, the eminent American ichthyologist Dr. Robert Rush Miller extended a kind invitation to the senior author to examine fishes housed in the University of Michigan collection for the presence of monogenetic trematodes.

Approximately 25 species of Monogenea new to science were recovered. The majority of these species were forms recovered from freshwater fishes captured in Mexico by Dr. Miller and his associates. Most of the fishes involved were members of the family Cyprinidae (minnows).

It is our intention, in a series of studies, to furnish a morphological and systematic account of these parasites. The present paper, constituting the first of five (or more) parts, is concerned with these topics: 1) an account of the cyprinid fauna of Canada, the United States and Mexico; 2) a morphological study of the monogenean genus *Dactylogyrus* Diesing, 1850; 3) notes on the host-parasite affinities existing between cyprinid fishes and *Dactylogyrus* parasites; and 4) a list of the freshwater Mexican fishes housed in the University of Michigan collection found to be harboring monogenetic trematodes.

NOTES ON THE FAMILY CYPRINIDAE WITH SPECIAL REFERENCE TO THE CYPRINIDS OF THE WESTERN HEMISPHERE

The Cyprinidae ("minnows") is the largest single family of freshwater fishes, numbering approximately 250 genera containing about 2,000 species (R. R. Miller, personal comunication). Most are restricted to fresh waters although a few are capable of surviving in environments of limited salinity. Marshall (1966) points out, for example, that populations of *Rutilus rutilus, Cyprinus carpio, Abramis brama* and *Barbus brachycephalus* inhabit the Caspian and Aral Seas and lay eggs which will survive and develop in saline concentrations of eight to ten parts per thousand. (For comparison, the average saline concentration of sea water is generally taken to be in the vicinity of 35 parts per thousand). A more striking case is that of the Far-Eastern rudd, *Leuciscus brandti* Walbaum, which is the only marine cyprinid species of the Soviet fauna. It lives most of its life in the sea, returning to fresh waters to spawn. Although a few additional exceptional cyprinids exist, the general rule remains: minnows possess little or no tolerance for saline environments.

Examination of Fig. 1 indicates that minnows are quite well represented in Canada, the United States and Mexico. Although there are a few genera common to all three countris, we can state that the minnows of Mexico resemble those of the United States more than they resemble the Canadian forms. Several genera are common to Mexico and the United States, including *Agosia, Gila, Dionda* and the cosmopolitan *Notropis*. A very few genera, as *Algansea,* are apparently endemic to Mexico. In both countries the genus best represented is *Notropis*.

THE MONOGENEAN GENUS *DACTYLOGYRUS* DIESING, 1850

Dactylogyrus is the largest genus of the order Monogenea; a recent check of the literature indicates a total of 364 species, exclusive of possible synonymy. *Dactylogyrus* is very closely associated with cyprinid hots; these host-parasite relationships are treated in some detail in the section following.

This trematode genus constitutes a morphologically homogeneous group, with some aberrant exceptions. In a genus containing a large number of species, there are obvious taxonomic problems. The establishment of a new species requires painstaking comparative study. As *Dactylogyrus* species can be considered morphologically "simple" forms, taxonomic decisions are often extremely difficult.

As an aid in defining this genus, illustrations of *Dactylogyrus albertensis* Price and Arai (1967) are furnished. (Figs. 2 to 7).

One of the major problems in the systematics of the Monogenea is that of inadequate descriptions of species, such as several given by Mueller (1938). Goals in every morphological description should be completeness and attention to detail, so that the description is able to withstand the test of time.

Another problem is a deplorable lack of usage of standardized anatomical terms

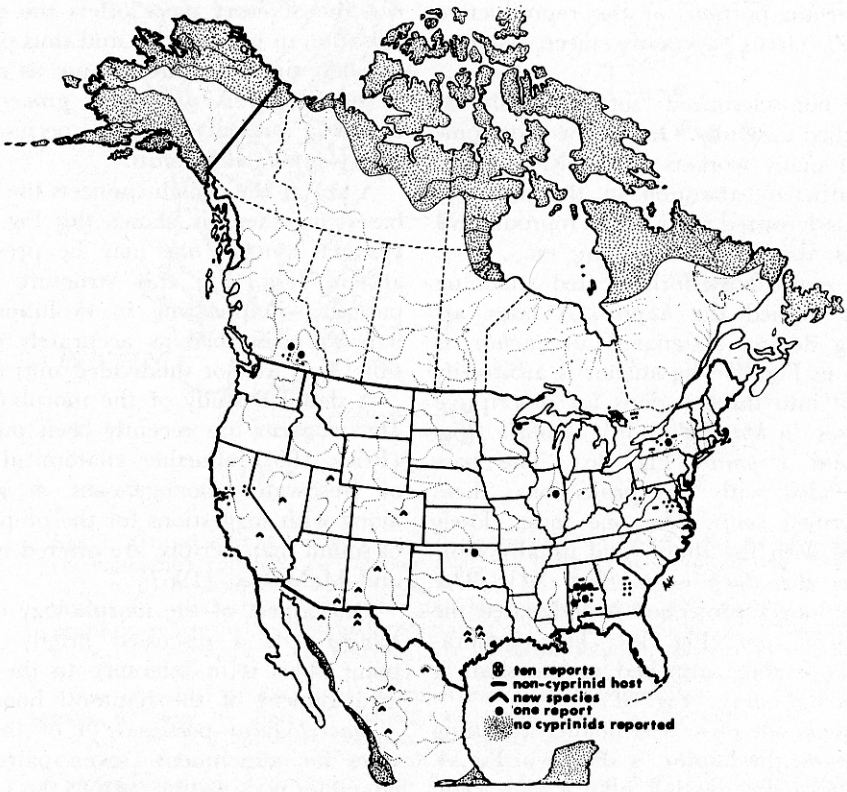

Fig. 1. Map illustrating the reports of *Dactylogyrus* parasites reported from gresh-water fisher of Canada, the United States and Mexico. The majority of these parasites have been reported from cyprinid hosts.

in descriptions. The seriousness of this inconsistency is reflected in an editorial note appearing in a recent issue of the Journal of Parasitology. This note, appearing at the completion of a paper on monogenean taxonomy, stated (in part): "It is hoped those concerned with these small forms will get together and resolve this question. Taxonomy is sufficiently difficult without quibbling over alternate terminologies."

Fig. 2 depicts a ventral view of *Dactylogyrus albertensis*. Certain parts of a dactylogyrid are sclerotized; they are sometimes referred to as the "hard parts" of the organism. These sclerotized structures are excellent guides to speciation in most cases. They consist of the devices (anchors and hooks), by which the parasite attaches itself to the host's tissues, and certain portions of the reproductive systems (cirrus, accessory piece, vagina, etc.)

The non-sclerotized "soft parts" should be studied carefully. One of the shortcomings of many workers in the Monogenea is insufficient attention to the anatomy of non-sclerotized parts of the reproductive systems, the digestive system, etc.

The entire posteriorly-located attaching disc is termed the *haptor*. A large attaching device, designated an *anchor, is* shown in Fig. 3. The anchor is arbitrarily divided into three regions for descriptive purposes: a *base* (Fig. 3a), a *shaft* (Fig. 3b) and a *point* (Fig. 3c). The base is provided with two projections; these are termed *roots*. The one most closely aligned with the shaft (and usually shorter) is the *deep root* (Fig. 3d). The usually longer projection is designated the *superficial root* (Fig. 3e). The membranous appendage attached to the shaft is the *anchor wing* (Fig. 3f).

A *hook,* one of several smaller attaching devices on the haptor, is shown in Fig. 4. It is normally divided into a *base* (Fig. 4a), a *shaft* (Fig. 4b) and a sickle-shaped termination (Fig. 4c). The termination is provided with an *opposable piece* (Fig. 4d). Although sometimes difficult to observe, a *domus* can usually be seen (Fig. 4e) in association with each hook.

Some of the best morphological characters for comparative studies are seen in the sclerotized portions of the male reproductive system, the *copulatory complex* (Fig. 5). This complex is composed of two portions, *viz.,* a *cirrus* (Figs. 5a, b) and an *accesory piece* (Figs. 5c, d). The cirrus consists of an inflated *base* (Fig. 5a) and a *tube* (Fig. 5b). The accesory piece, articulated with the cirrus base, arises as a main *shaft* (Fig. 5c); the shaft is usually divided into two (or more) *rami* Figs. 5d, e). If a ramus becomes secondarily bifid, each of these smaller portions is termed a *secondary ramus.* Of all the structures present in species of *Dactylogyrus,* the accesory piece offers the greatest variation in morphology and thus provides the best single feature for use as a guide in speciation. A *digitiform process* (Fig. 5f) is a present in some species, as in *Dactylogyrus albertensis.*

A *dorsal bar,* which connects the anchor bases together, is shown in Fig. 6. A vestigial *ventral bar* may be present or absent (Fig. 7); this structure is apparently disappearing in evolution. The bars are described as accurately as possible, but are not subdivided into regions.

A detailed study of the morphology of *Dactylogyrus* has recently been published (Price, 1967). Further anatomical details of freshwater monogeneans in general, along with suggestions for the preparation of sound manuscripts, are offered by Price and McMahon (1967).

One aspect of the morphology of *Dactylogyrus* is a discussed briefly at this point. This is in reference to the spatial arrangement of the haptoral hooks.

Dactylogyrus possesses 14 of these devices for attachment (seven pairs); this character is shared by most of the parasites belonging to the family Dactylogyridae. As the hooks of a given species are likely

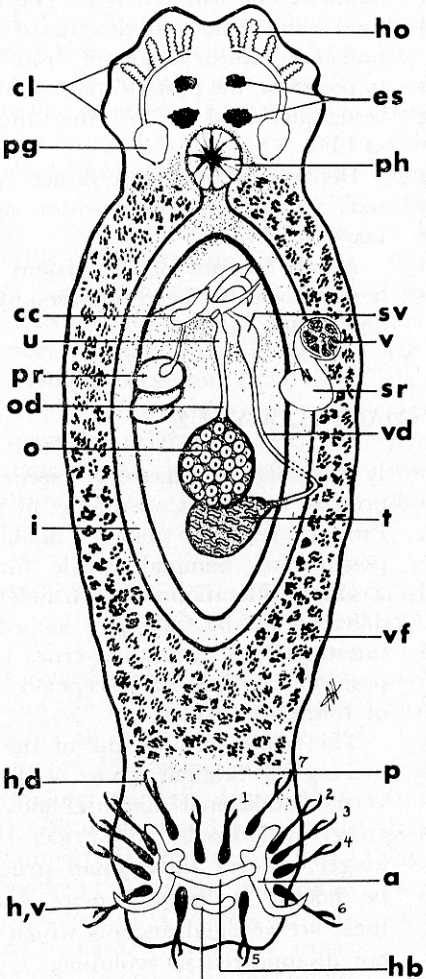

Fig. 2

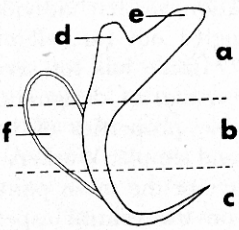

Fig. 3

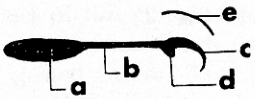

Fig. 4

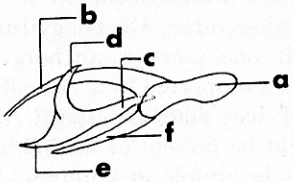

Fig. 5

Fig. 6

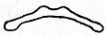

Fig. 7

Fig. 2. Ventral view of *Dactylogyrus albertensis* Price and Arai, 1967. a: anchor; cc: copulatory complex; cl: cephalic lobe; es: eyespot; hb: haptoral bar (dorsal); h, d: hook, dorsal; h, v: hook, ventral; ho: head organs; i: intestine o: ovary; od: oviduct; p: peduncle; pg: pharyngeal gland; ph: pharynx; pr: prostatic resorvoir; sr: seminal receptacle; sv: seminal vesicle: t: testis; u: uterus; v: vagina; vd: vas deferens; vf: vitellarial follicles. (Numerals refer to haptoral hooks.) Fig. 3. An anchor. a: region of base; b: region of shaft; c: region of point; d: deep root; e: superficial root; f: wing. Fig. 4. A haptoral hook. a: base; b: shaft; c: sickle-haped termination; d: opposable piece; e: domus. Fig. 5. Copulatory complex. a: cirrus base; b: cirrus tube; c: main shaft of accessory piece; d, e: rami of accessory piece; f: digitiforn process (protruding from cirru base). Fig. 6. Dorsal haptoral bar. Fig. 7. Vestigial ventral haptoral bar.

to vary considerably in shape and/or size, it is necessary to have a reliable means of hook designation, so that individual hooks might be singled out for reference.

Dr. J. D. Mizelle has for several years employed a system of designation having the desiderable properties of being both meaningful and simple. Workers have long noted that five or the seven pairs of hooks are located on the ventral aspects of the haptor, with the two remaining pairs on the dorsal surface. (This arrangement is ilustrated in Fig. 2).

The ventral hooks are assigned the numbers one through five. The anteriormost ventral hook is designated "1"; the numbers run in sequence from anterior to posterior, the posteriormost ventral hook being identified as "6", the anteriormost as "7".

Departures from this rather "generalized" arrangement often possess significant taxonomic value.

A full account of this system of numbering hooks has been prepared by Mizelle and Crane (1964).

DIAGNOSIS OF DACTYLOGYRUS

Modified from Price (1967):

"Dactylogyridae, Dactylogyrinae: Haptor with one pair of anchors (dorsal), their bases supported by a (usually) simple haptoral bar, likewise dorsal. A ventral bar might be present or absent; if present, it might be simple or complex. Hooks 14 in number (7 pairs). Hooks of a given species usually similar in shape; may be nearly equal in size, or might exhibit a wide range of sizes. In some, one or more small sclerotized structures might be present in haptor. Four eyespots. Head organs (on either side) composed of four glandular structures connected by a duct to a larger pharyngeal gland. Copulatory complex composed of a cirrus and a basally articulated accessory piece. Vagina present or absent, variable in position. Prostatic reservoir single or double. Testis postovarian. Seminal vesicle formed by a simple dilatation of vas a deferens; vas deferens usually (always?) looped around intestinal limb. Intestinal crura confluent posteriorly. With one excepcion, parasites of freshwater fishes".

The senior author, one of the workers making the original report of the controversial "additional" haptoral hooks in *Dactylogyrus* (Mizelle and Price, 1963) no longer believes these small structures to be hooks. It appears more likely that these are vestigial anchors which have all but disappeared in evolution.

DACTYLOGYRUS AS PARASITES OF CYPRINID FISHES

Numerous workers in the Monogenea have recognized the close relationship exting betwene many monogenetic trematodes and their hosts, *i.e.*, these trematodes exhibit great specificity for certain hosts.

Hargis (1957) studied the specificity of 3,338 monogenetic trematodes (75 species) recovered from 415 host specimens (49 species). He found that 89% of the worms were associated with a single host species, while an additional 10% were recovered from two host species. Only one of the 75 species was recovered from more than two host species.

Bychowsky (1957), in his monograph of the Monogenea, noted that of a total of 958 species (the total number of described monogeneans at that time), 806 (84%) were known only from a single host genus

while 711 (74%) were specific for one host species.

Mizelle, LaGrave and O'Shaughnessy (1943) showed that it was sometimes possible to accurately identify the host by reference to the monogenean parasites it harbored. This is possible, of course, only where very high specificity exists, as with Monogenea.

The present senior author (1966) removed the gills of 300 specimens of the mosquitofish, *Gambusia a. affinis* (Baird and Girard). Examination of gills resulted in the recovery of more than 1,000 gill trematodes. Without exception, these were identified as *Urocleidus seculus,* the same species of parasite originally described from the mosquitofish by Mizelle and Arcadi in 1945.

These and many other studies show that, generally speaking, monogeneans exhibit a very high degree of specificity for certain hosts.

A survey of the literature reveals that *Dactylogyrus* is highly specific for cyprinid fishes. Approximately 89% of the 346 species of *Dactylogyrus* were originally described from minnow hosts.

Reference to Fig. 1 indicates that instances of *Dactylogyrus* occurring on non-cyprinid hosts are few in number. More than 100 species of this genus of parasites have been dscribed from fishes in Canada and the United States. Twenty-eight cyprinid genera have thus far been reported as hosts in North America; on a world basis, 78 cyprinid genera have been shown to harbor *Dactylogyrus.*

MONOGENETIC TREMATODES RECOVERED FROM MEXICAN FRESHWATER FISHES

Species of *Dactylogyrus* have now been recovered from the following cyprinids of Mexican origin (all fishes were housed in the University of Michigan collection): *Agosio chrysogaster* Girard; *Algansea affinis* Regan; *Gila conspersa* Garman; *G. nigrescens* (Girard); *Dionda rasconis* (Jordan and Snyder); *Notropis chihuahua* Woolman; *N. formosus* (Girard); *N. garmani* Jordan; *N. nazas* (Meek); *N. ornatus* (Girard); *N. sallaei* (Günther) and *N. stramineus* (Cope). Also recovered from various species of *Notropis* were new species of the viviparous monogenean *Gyrodactylus.*

Additional monogenetic trematodes (other than *Dactylogyrus)* were recovered from *Ictalurus pricei* (Rutter) (family Ictaluridae) and from two species belonging to the family Poeciliidae: *Ilyodon furcidens* (Jordan and Gilbert) and *Poecilia mexicana* Steindachner.

All recovered parasite species wil be described or redescribed during the course of this study. Location, catalog numbers, will be given with individual descriptions.

MEXICAN FRESHWATER FISHES FOUND NEGATIVE FOR MONOGENETIC TREMATODES

In a study of parasites occurring in a specific geographical area, it is important that hosts proving negative for parasites also be listed.

In the following list, the negative host species are listed under the families to wich they belong. The areas from wich the fishes were taken are given. The catalog number accorded each fish species by the University de Michigan is given in parentheses; this number is furnished in the event that futur workers might wish to make additional examinations of this material.

It might be well to point out that a single examination (or even several examinations) of a host species does not constitute reliable proof that the host in question is negative for parasites. Every potential host should be thoroughly examined whenever opportunity arises.

An example of the value of repeated examinations can be furnished by the senior author. Until recently, the North American ictalurid catfishes (Ictaluridae) were found to harbor only two species of Monogenea, *viz.*, *Cleidodiscus pricei* Mueller, 1936 and *C. floridanus* Mueller, 1936. The gills of several hundred catfishes were examined before recovery of a new monogenean, *Cleidodiscus bychowskyi* (Price and Mura, in press).

ICTALURIDAE

Ictalurus dugesi (Cat. 178354) — Río de Talpa at San Juan del Mosco, 9 mi. W of Mascota, Jalisco.

CYPRINODONTIDAE

Cyprinodon eximius (Cat. núm. 182348) — near El Sauz; Chihuahua.

Cyprinodon macularius (Cat. núm. 133142) — Pond, 35 mi. S of Mexicali, Baja California.

POECILIIDAE

Gambusia longispinus (Cat. núm. 130382) — Cuatro Ciénagas, Coahuila.

Poecilia latipunctulata (Cat. núm. 97605 — Río Guayalejo, Tamaulipas.

CATOSTOMIDAE

Catostomus plebeius (Cat. num. 161669) — Río Trujillo (locally, Río Florido), 1 mi. W of Rancho Grande, Zacatecas.

Catostomus wigginsi (Cat. num. 157247) — Río Dolores Valley, trib. of Río Sonora basin, 32 mi. E. of Magdalena, Sonora.

CYPRINIDAE

Campostoma ornatum (Cat. num. 161673) — Río Trujillo (locally, Río Florido), 1 mi. W of Rancho Grande, Zacatecas.

Gila modesta (Cat. num. 186473) — Arroyo El Chorro, Coahuila.

Moxostoma mascotae (Cat. num. 178353) — Río de Talpa, at San José del Mosco, 10 mi. W of Mascota, Jalisco.

Notropis calientis (Cat. num. 161673) — Río de Morelia, vic. of Undamea, Michoacán.

Notropis jemizanus (Cat. num. 94436) — Río San Juan, San Juan.

Notropis rutilus (Cat. num. 179172) — Río Salado, 2 mi. NE. of Sacramento, along Hwy. 30, Coahuila.

LITERATURE CITED

BYCHOWSKY, B. E., 1957. Monogenetic Trematodes — Their Systematics and Phylogeny, (Originally in Russian. English translation edited by W. J. Hargis, Jr. Graphic Arts Press. Washington, D. C., pp. 1-509.

HARGIS, W. J., Jr., 1957. The Host Specificity of Monogenetic Trematodes, *Expt. Parasit. 6,* (6), pp. 610-625.

MARSHALL, N. B., 1966. The Life of Fishes, The World Publishing Company. Cleveland-New York. pp. 1-402.

MILLER, R. R. (Personal communication).

MIZELLE, J. D., D. R. LAGRAVE y R. P. O'SHAUGHNESSY, 1943. Studies on Monogenetic Trematodes. IX. Host specificity of *Pomoxis Tetraonchinae, Amer. Midl. Nat. 29,* pp. 730-731.

MIZELLE, J. D. y J. W. CRANE, 1964. "Studies on Monogenetic Trematodes. XXIII. Gill parasites of *Micropterus salmoides* (Lacépède) from a California pond", *Trans. Amer. Micr. Soc.* vol. 83, pp. 343-348.

MIZELLE, J. D. y C. E. PRICE, 1963. Additional Haptoral Hooks in the Genus *Dacty-*

logyrus", Jour. Parasit. 49, (6), pp. 1028-1029.

MUELLER, J. F., 1938. Additional Species of North American Gyrodactyloidea. Amer. *Midl. Nat. 19,* 1 pp. 220-235.

PRICE, C. E., 1966. Host-specifity in the order Monopisthocotylea (Trematoda: Monogenea, *ASB Bull. 13,* 2, p. 44. (ABSTRACT ONLY).

PRICE, C. E., 1967. A Revised Definition of the Monogenetic Trematode Genus *Dactylogyrus,* with descriptions of Four New Species, *Proc. Hel. Soc. Wash.* 34, 2, pp. 117-124.

PRICE, C. E. Y H. P. ARAI, 1967. The Monogenean Parasites of Canadian Freshwater Fishes, *Canadian Jour. Zool.* 45, 6, pp. 1235-1245.

PRICE, C. E. Y T. E. MCMAHON, 1967. The Monogenetic Trematodes of North American Freshwater Fishes, *Riv. Parassit.* 28, 3, pp. 177-220.

PRICE, C. E. Y A. MURA, (In press). The Proposed Synonymy of the Monogenetic Trematode Genera *Cleidodiscus* Mueller, 1934 and *Urocleidus* Mueller, 1934, with the Description of *Cleidodiscus bychowskyi* n. sp. *Proc. Hel. Soc. Wash.*