

ARE THERE TROPICOPOLITAN MACROTHRICID CLADOCERA?

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RESUMO - EXISTEM CLADÓCEROS MACROTRICÍDEOS TROPICOPOLITAS?

Dois cladóceros macrotricídeos, *Guernella raphaelis* descrita na África Ocidental Francesa e *Iheringula paulensis* descrita na região de São Paulo (Brasil), apareceram no sul da Flórida (Everglades). As tentativas para determinar se estas espécies são as mesmas que as das populações-tipo, ou se são as mesmas de outros continentes (levando atualmente os mesmos nomes) são frustradas devido à carência de machos e fêmeas efípias nas coleções. Para *Guernella* a distribuição de frequência de tamanho mostra uma considerável diferença entre a população-tipo e aquelas de Sri Lanka e Everglades. Análises em microscópio de varredura (SEM) também sugerem que há diferenças entre as populações, embora estas diferenças não possam ser definidas tão detalhadamente quanto necessário. Minha sugestão, baseado em estudos similares, é que os grupos são diferentes ao nível de espécie. Para *Iheringula*, pouco pode ser dito pois a deficiência em fêmeas é grande. O que é necessário para os grupos discutidos acima e para Cladocera em geral quando populações cognatas

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são comparadas, é uma amostragem maior, nos diferentes locais de ocorrência, contendo fêmeas efipliais, efipios e machos nos diferentes estágios de desenvolvimento.

ABSTRACT - ARE THERE TROPICOPOLITAN MACROTHRICID CLADOCERA?

Two macrothricid cladocerans, *Guernella raphaelis* described from French West Africa and *Iheringula paulensis* described from the São Paulo region of Brazil, have turned up in the Everglades in southern Florida. Attempts to determine if they are the same species as the type populations, or as those from other continents presently bearing the same names, are thwarted by the general lack or scarcity of males and ehippial females in the collections. For *Guernella* the size-frequency distributions show considerable differences between the type population and those from Sri Lanka and the Everglades. Scanning electron microscopy photographs also suggest that there are differences between the populations, although these cannot yet be defined narrowly enough. My guess, based on similar studies of chydorid cognates, is that the taxa are different at the species level. For *Iheringula* little can be said, as males are completely lacking. What is needed for both taxa, and for Cladocera in general when cognate populations are being compared, are large samples from the various localities, each containing ehippial females, ehippia, and all instars of males.

INTRODUCTION

My research to this time has been concerned almost entirely with Cladocera in the family Chydoridae. Here the same binomens, most often originating from species described in Europe, have been transferred all over the World, and as a result scientists complacently have come to regard the

chydorids as cosmopolitan in distribution, meaning that the same species occur on more than one continent. The production of very resistant resting eggs when the animals become gamogenetic and the presumed easy passive dispersal of these eggs by wind or birds intuitively support cosmopolitanism, and hence there seemed to be no reason to question the validity of the concept.

What we have been finding in the chydorids, however, through detailed morphological comparisons of cognate taxa on different continents is that the taxa are different, sometimes very markedly so, and always with the differences being great enough that there should be no dispute about the taxa being different species. The accepted situation with the chydorids, and with Cladocera in general, seems to be like saying that all Chinese look alike, meaning that without looking at the details but only at those characters that identify people as being Chinese, one cannot distinguish them as individuals. Many studies have now convinced me that probably there is no cosmopolitanism at all among the chydorids (see FREY 1986a, 1986b for reviews). The family originated at least a couple hundred million years ago, and the species have been extremely stable over time. Hybridization between present day species of chydorids either cannot be induced in the laboratory at all, or when it does occur the hybrid population can reproduce only by parthenogenesis, which involves no meiosis and no possibility of backcrossing with the parents. Moreover, in nature any hybrid population will be eliminated whenever environmental conditions degenerate appreciably.

Of the 11 families presently in the Cladocera, the Macrothricidae is the one most closely related to the Chydoridae. I have never before worked with it seriously, but in some samples from the Florida Everglades collected in July 1985 I found two species that had not been reported to that time from North America. One is the species *Iheringula paulensis* described from Brazil by Sars in 1900, the other

Guernella raphaelis described by Richard in 1892 from French Equatorial Africa. *Iheringula* has been collected only once since Sars, and that also in Brazil (BREHM, 1938). *Guernella* over the past three decades has been collected rather widely in the African and Asian Topics, but only in Argentina and Surinam from the Neotropics. Florida is so far away from any of these locations that my immediate question was, are the taxa in Florida the same as those in Brazil and West Africa?

Guernella raphaelis Richard, 1892

Guernella raphaelis is the more interesting of the two taxa because of its wide distribution in the Tropics, although generally in very low abundance, and also because I could get access to several large samples, including Richard's type series from Africa and Daday's from Sri Lanka. *Guernella raphaelis* was described from near the mouth of the Congo River by RICHARD (1892). In 1898, Daday described a second species *Guernella ceylonica* from Sri Lanka, which he claimed was different from Richard's. In a few intermediate papers BREHM (1939, 1951, 1953) recorded the presence of *Guernella* in scattered localities in Asia and Africa, and although he suggested the two taxa might be the same, he never really urged that they be combined. This was done by THOMAS (1861), and since then only a single species has been claimed for the World. The species is now recorded in the literature from French Equatorial Africa (= Gabon) (RICHARD, 1892), Belgian Congo (BREHM, 1939), Uganda (THOMAS, 1961), Lake Chad region (REY & SAINT-JEAN, 1968, 1980; KORINEK, 1984), Sri Lanka (DADAY, 1898, FERNANDO, 1974), India (BREHM, 1953), Malaysia (IDRIS, 1979, 1983), Philippines (MAMARIL and FERNANDO, 1978), New Guinea (BREHM, 1951); and from South America Argentina (PAGGI, 1976) and Surinam (KORINEK, 1984), along with unpublished records from Brazil, British Guiana, and Venezuela.

In many respects, *Guernella raphaelis* parallels the

species of chydorids that seem to be distributed everywhere in the Tropics and thus are considered to be truly (?) tropicopolitan.

The material available for study consists of: 1) 109 specimens from RICHARD'S (1892) collections from French Equatorial Africa that were available to him at the time he described the species (A LECTOTYPE has been selected from these specimens); 2) 46 specimens from Sri Lanka on slides that DADAY (1898) used describing *Guernella ceylonica* (Although most specimens are in poor condition, a LECTOTYPE has been selected from among them); 3) 362 specimens from a sample collected from Nuwara Wewa in Sri Lanka by C.H. Fernando in May 1973; and 4) the 66 specimens recovered from the Everglades in July 1985. The Fernando sample and the Everglades sample both contained mature males, and the Fernando sample in addition contained 9 ehippial females.

Length-frequency distributions (Fig. 1) of three of these samples show a number of important features. First, the specimens in Richard's sample seem to be considerably smaller than those from the Everglades and Sri Lanka, i.e., the smallest individuals are smaller, and the largest individuals are much smaller. RICHARD (1892) himself noted that the largest specimens did not exceed 0.4 mm, and that the population averaged 0.35 mm, which is completely substantiated in the particular sample reported here. DADAY (1898) reported the same size, given as 0.3-0.4 mm, for his population from Sri Lanka. However, Fernando's population from Sri Lanka is considerably larger, extending from 0.26 to 0.51 mm, and the Everglades population is even larger, ranging from 0.29 to 0.58 mm. How stable the ontogenetic size of a population of Macrothricidae is under varying environmental conditions I cannot say, but in the chydorids the taxa seem to be almost remarkably unvarying, both over space and time. The Everglades and Sri Lanka taxa seem to be quite similar, at least as to the sizes of males and ehippial females. The few individuals of larger sizes in

the Everglades sample may indicate a lesser intensity of predation on larger specimens and hence a greater likelihood that occasional specimens will survive to molt to larger sizes.

The sample from Africa is good, in that most of the large females are still carrying their embryos. The smallest female carrying embryos is indicated by the arrow in Figure 1. Specimens smaller than this are aggregated into two distinct peaks, representing two prereproductive instars, as in the chydorids. In the other two samples, only a single parthenogenetic female was still carrying eggs, the others having lost theirs during preservation. Thus we cannot say precisely at what length the females become reproductive, although in the Sri Lanka sample there seem to be two well defined frequency spikes, which would correspond to the two prereproductive instars of the African population. This interpretation is supported by the mature males covering roughly the same size range as instar II in the females, but extending beyond here into sizes that certainly overlap those of mature females. Quite possibly the males do not have just a single mature instar, as in the chydorids, but molt and grow an indefinite number of times, as in the daphniids.

Scanning electron micrographs (SEMs) have been made of all three populations. The results are not conclusive yet, but there seem to be differences in shell and head sculpturing, in shape and markings of the rostral region, and particularly in the secondary setation of the antennules of mature males. Chydorids have only three instars of males, the first two of which are prereproductive. In these instars there is a definite ontogeny in the gradual development of characters that are functional only in mature specimens. From the material of this study, however, I cannot say how many prereproductive and reproductive instars there are in *Guernella*, nor what the sequence of changes is in the development of the male reproductive characters.

It looks as if these three populations, each from

5 [*Guernella raphaelis*

EVERGLADES, FLORIDA
(66)

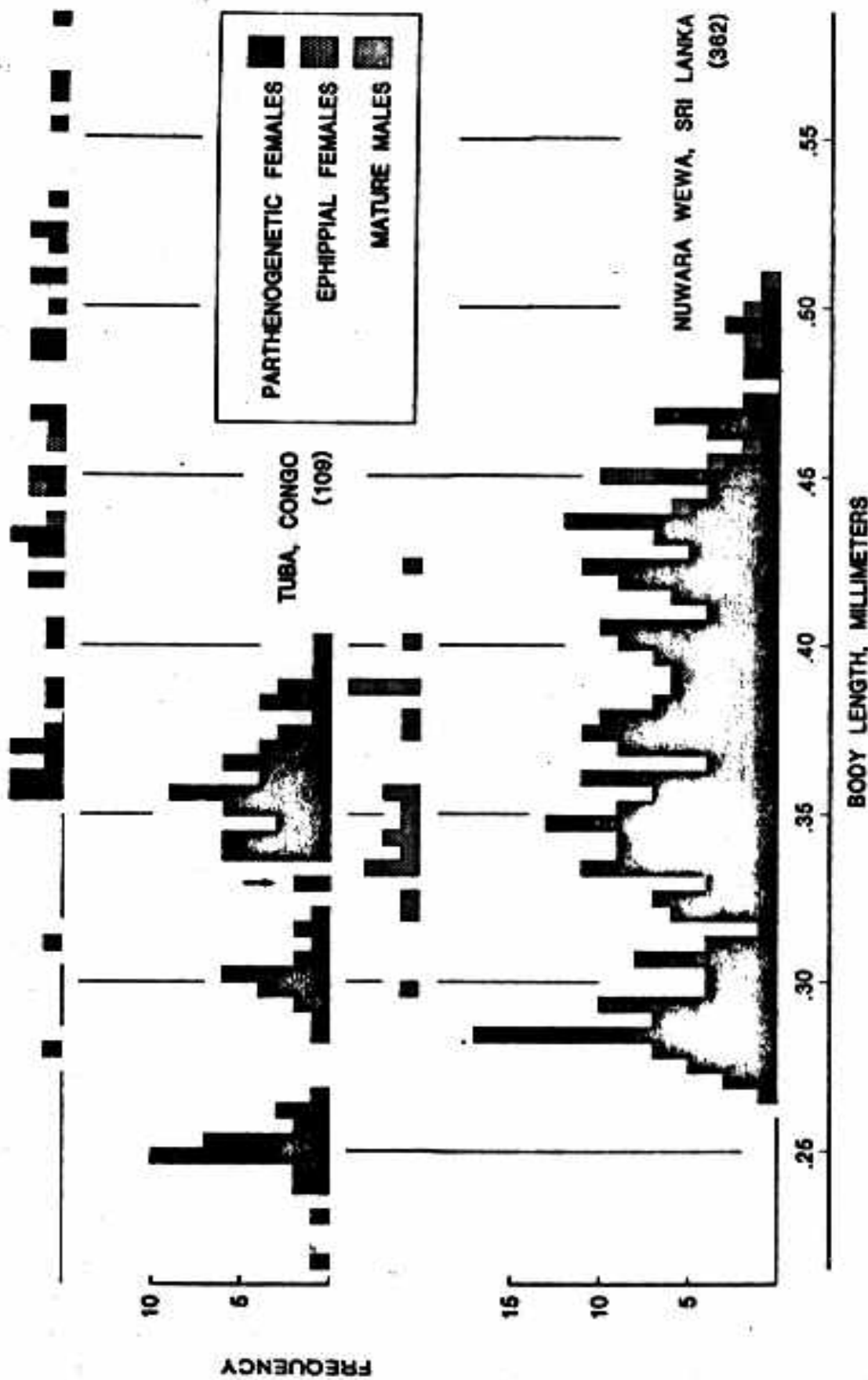


Fig. 1. *Guernella raphaelis*: size-frequency distributions, separated by sexual stage of the individuals where possible, of the type population from French Equatorial Africa (Gabon) and of two populations from Sri Lanka and the Florida Everglades. The arrow in the middle diagram designates the smallest parthenogenetic female with embryos in its brood pouch.

a different continent, are closely related but are not completely identical. More study is needed to decide the issue, and this must be based on large populations containing all the reproductive instars. My guess is that they will probably be found to be different.

What degree of similarity there is between the South American and Florida populations can only be guessed at the moment. Because the taxon probably occurs only in the extreme southern part of the United States and from here more or less continuously through Central America (?) into South America, it is rather likely they may be the same. This is probably true of other species of Cladocera described from Brazil that occur as far north as the southern states. But for something like the honeycombed species of *Chydorus*, which in North America presently occurs only in the glaciated region (FREY, 1986a, 1986c) and in South America occurs at least from northern Argentina to central Brazil (FREY, 1986c), the species present are completely different. The taxa are completely isolated now and certainly were even during the glacial ages.

Iheringula paulensis Sars, 1900

This taxon is completely different in its distribution from that of *Guernella*. It was described from specimens raised from a dried mud-macrophyte sample collected in the neighbourhood of São Paulo. The taxon apparently has been collected only one additional time, in Brazil (BREHM, 1938), until our sample from the Everglades. Sars placed this taxon in a new genus, mainly because of the unique structure of trunklimb V and the notch between the head and shell. Later authors placed it in *Macrothrix*, and most recently SMIRNOV (1976) has placed it in *Echinisca*.

The size-frequency distribution of Sars' type population (Fig. 2) begins essentially with the smallest reproductive individuals and has almost none of the

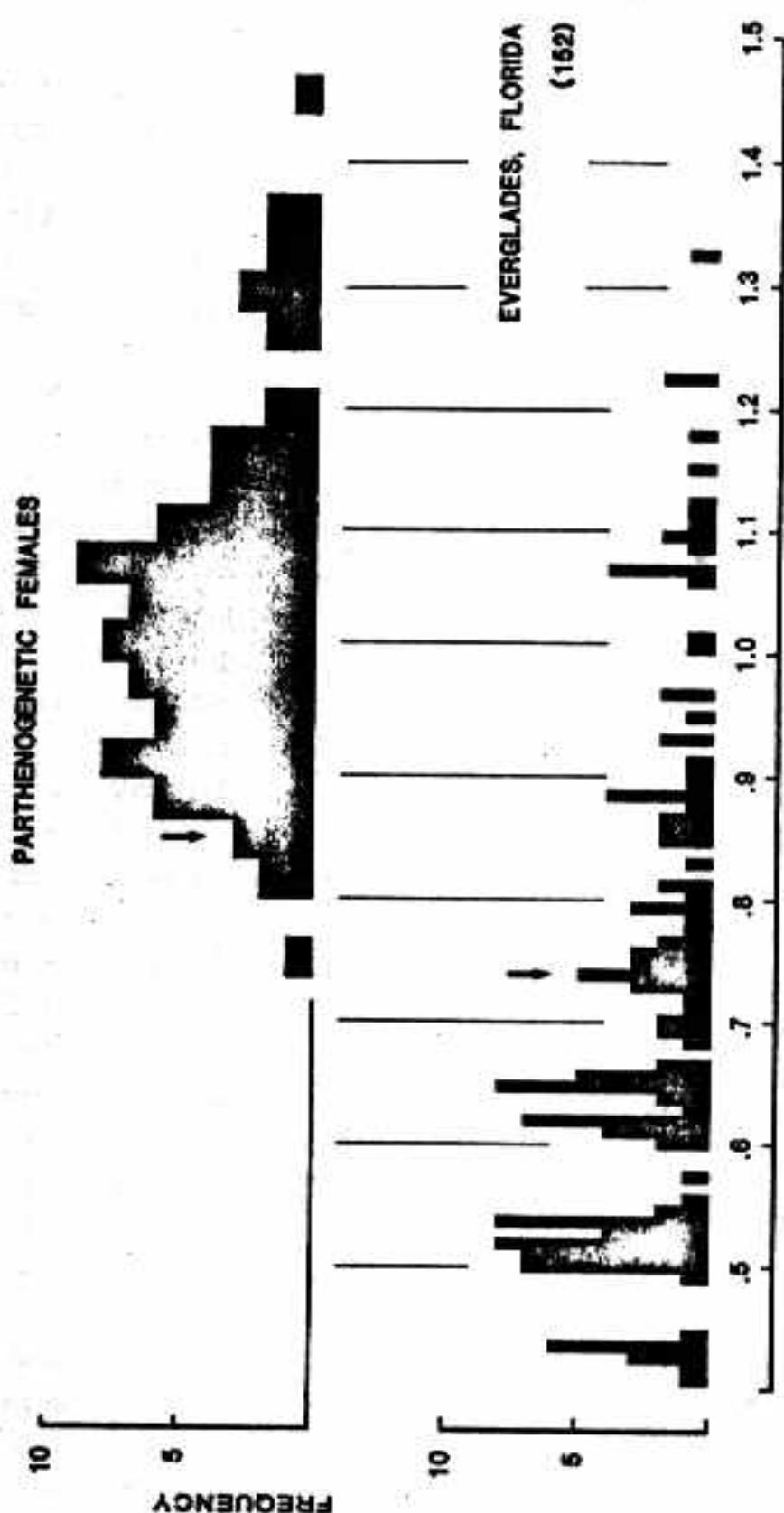


Fig. 2. *Iheringula paulensis* (also variously placed in the genera *Macrothrix* and *Echinisca*): size-frequency distributions of the type population from Brazil and of a population from the Florida Everglades. The arrows in the two diagrams designate the smallest parthenogenetic females with embryos in their brood pouches.

prereproductive instars. These specimens were picked out individually by Sars from aquaria maintained over two years. Evidently he didn't save many of the small specimens that must have been present. Ehippial females were in the sample but no males, although Sars reported collecting a considerable number of them, and he has drawings of them in his paper. The male is said to be very small, scarcely exceeding 0.5 mm in length.

In the Everglades population there is a sequence of frequency spikes at the small end of the distribution, which probably represent different instars. Few specimens retained their eggs on preservation, the smallest of which measured 0.73 mm. Thus, in this population there probably are three prereproductive instars. Reproduction seems to occur at a smaller size in the Florida population, but because the Florida population was collected and the Brazilian population selected, there may be no major difference. The larger size of specimens in the Brazilian sample may be real, i.e., a characteristic of the taxon, or it may have resulted from Sars culturing his material in the absence of large predators. Sars reported that the largest specimens he obtained measured 1.64 mm, whereas the largest Florida specimen measured only 1.32 mm. Size of specimens at the large end of the distribution is somewhat meaningless in these Cladocera, because, having an indeterminate growth pattern, they continue to molt and grow as long as they live. Truncation of the upper size range probably results from size-selective predators in the habitat. The SEMs give little help in detecting differences, as no males are present at all, and ehippial females occurred only in the Brazil collection.

Thus, we cannot yet answer the question about the possible conspecificity of these various populations. Based on my studies of the chydorids I suspect that these macrothricids are also different, although there is no positive evidence yet, only hints. Details of morphology, based on SEMs and light microscopy, will be reported in another paper.

REFERENCES

- BREHM, V. Dritter Bericht über die von Dr. O. Schubart in Brasilien gesammelten Onychura. *Zool. Anz.*, 122 (3/4): 94-103, 1938.
- _____. Cladocera. *Explor. Parc Nat. Albert Mission H. Damas 1935-1938*, 7: 3-12, 1939.
- _____. Sobre la microfauna de las aguas dulces de diversos países extraeuropeos. *Publ. Int. Biol. Apl.*, Barcelona, 83-100, 1951.
- _____. Indische Diaptomiden, Pseudodiaptomiden und Cladocera. *Österr. Zool. Zeitschr.*, 4: 241-345, 1953.
- DADAY, E. Mikroskopische Susswasserthiere aus Ceylon. *Termés. Füzetek, Anhangsheft*, 21: 1-123, 1898.
- FERNANDO, C.H. Guide to the freshwater fauna of Ceylon (Sri Lanka). *Bul. Fish. Res. Sta.*, Sri Lanka (Ceylon), 24 (1,2): 27-81, 1974. (Suppl. 4)
- FREY, D.G. The non-cosmopolitanism of chydorid Cladocera: implications for biogeography and evolution. In: HECK, K.L. & GORE, R.H., ed. *Biogeography of the Crustacea*. Balkema, Vijverweg. (no prelo)
- _____. The taxonomy and biogeography of the Cladocera. In: CLADOCERA SYMPOSIUM, Budapest, 1986. *Proceedings...* (no prelo)
- _____. Comparison of *Chydorus faviformis* from North America with honeycombed taxa from other continents (Cladocera, Chydoridae). *Phil. Trans. Roy. Soc. London*. (no prelo)
- IDRIS, B.A.G. *The taxonomy and distribution of Malaysian freshwater Cladocera (Crustacea)*. Ontario, Univ.

- Waterloo, 1979. (Dissertação)
- IDRIS, B.A.G. Freshwater zooplankton of Malaysia (Crustacea: Cladocera). Penerbit Universiti Pertanian Malaysia.
- KORÍNEK, V. Cladocera. *Hydrobiol. Surv. Lake Bangweulu Luapula River Basin*, 13 (2): 1-117, 1984.
- MAMARIL, A.C. & FERNANDO, C.H. Freshwater zooplankton of the Philippines (Rotifera, Cladocera, and Copepoda). *Nat. Appl. Sci. Bull.*, 30 (4): 109-221, 1978.
- PAGGI, J.C. Cladoceros Macrothricidae nuevos para la fauna Argentina. *Physis B*, Buenos Aires, 35: 103-12, 1976.
- REY, J. & SAINT-JEAN, L. Les Cladocères (Crustacés, Branchiopodes) du Tchad (Première note). *Cah. O.R.S.T.O.M., ser. Hydrobiol.*, 2 (3/4): 79-118, 1968.
- _____. Branchiopodes (Cladocères). In: DURAND, J.R. & LÉVÊQUE, C., ed. *Flora et faune aquatiques de l'Afrique Sahelo-Soudanienne*. France, O.R.S.T.O.M., 1980. p. 309-32. (Doc. Tech., 44)
- RICHARD, J. Cladocères nouveaux du Congo. *Grimaldina Brazzai, Guernella Raphaelis, Moinodaphnia Mooquerysi*. *Mem. Soc. Zool. Fr.*, 5: 213-26, 1892.
- SARS, G.O. Description of *Iheringula paulensis*: a new generic type of Macrothricidae from Brazil. *Arch. Math. Naturvidensk.*, 22 (6): 1-27, 1900.
- SMIRNOV, N.N. *Macrothricidae i Moinidae fauny mira*. *Fauna USSR*. Rakoobraznyye, 1976. Tom. 1, vyp 3. 237p.
- THOMAS, I.F. The Cladocera of the swamps of Uganda. *Crustaceana*, 2: 108-25, 1961.

ACKNOWLEDGEMENTS

The Everglades samples were collected in July 1985 when I visited the region as a consultant to the Everglades National Park research staff. Richard's samples from French Equatorial Africa were in the collection Birge purchased from Richard in 1903. Daday's type material was borrowed from the Hungarian Natural History Museum, through the cooperation of L. Forró, and Fernando's sample from Sri Lanka was generously made available by his graduate student, Ranjani Rajapaksa. To all these persons I am most grateful. The study was supported in part by grant BSR 82-14600 from the National Science Foundation.

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