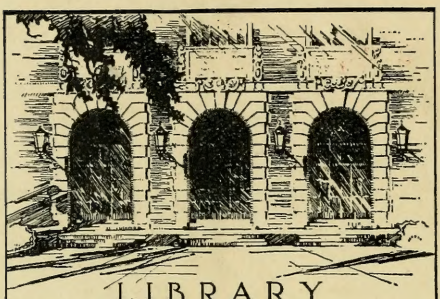

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THE OSTRACODS OF ILLINOIS

Their Biology and Taxonomy

WITH NINE PLATES

BY

C. CLAYTON HOFF

CONTRIBUTION FROM THE DEPARTMENT OF ZOOLOGY
OF THE UNIVERSITY OF ILLINOIS

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INTRODUCTION

The recent fresh-water ostracods of Illinois, or for that matter of North America, have received relatively little attention from either taxonomists or ecologists. One of the most obvious explanations for the neglect of study of the American fresh-water ostracods undoubtedly has been their relative absence from most open-water plankton samples. Thus they have been delegated little attention from various American investigators who have made detailed studies of other crustaceans such as copepods and cladocerans which are important as plankters in fresh waters. The group has also been overlooked by investigators working on the bottom faunas of American lakes and rivers because the ostracods, being small and active, readily escape from the usual bottom sampling apparatus. Even those investigators concerning themselves with aquatic vegetation and associated animals have often neglected the ostracods, largely perhaps because they were unable to make specific determinations for themselves, and there have been few American authorities to whom material might be submitted for identification. For anyone but the specialist, the specific determination of many of the species has been and still is almost impossible, or at least impractical because the literature is scattered and there are many dissensions in classification and nomenclature. Moreover, it takes considerable time to learn to locate the structures on which specific determination often rests. For these reasons, it is impractical for anyone not especially interested in the taxonomy of ostracods to identify any except the easily recognized species, or species from areas in which a fairly complete survey of the ostracod fauna has been made. The only areas in North America in which fresh-water ostracods have received more than minor consideration are Ohio, Illinois, Massachusetts, Florida, and Washington.

Apparently few investigators have cared to give their attention to an intensive study of ostracods. One reason for this undoubtedly is the difficulty of working in the group. As specific determination usually depends on minute details of the appendages isolated by careful and tedious manipulation, few American investigators have given prolonged attention to the group. Besides the mechanical difficulties encountered, there is a decided deficiency of literature in English, the papers that are available being old or unsuited to open the way readily to anyone desiring to begin work on these forms. Nearly all the more important papers are written in German, and since most of the genera and many of the species are not confined to any one continent, little can be done in the way of taxonomy without consulting these foreign publications.

The stigma of apparent lack of economic or biologic importance has perhaps led many investigators to ignore the ostracods. In contrast to

what is generally thought, however, the ostracods do play an important rôle in the economy of fresh waters. As most species feed on diatoms, bacteria, and minute particles of organic material in the water and are in turn food for many of the larger animals, chiefly fish, they certainly are of some economic significance. Very often, no doubt, a lack of emphasis on ostracods as food for fishes has been the result of an inability to determine taxonomically the species found. In practically all surveys concerned with the availability of food for fishes, the ostracods are identified only to genus, and in some publications all are listed under the blanket term "Cypridae." While it has been well known since the time of Forbes (1888) that many Illinois fishes consume ostracods as a part of their food, the extent to which fish sometimes ingest ostracods is not generally realized. One individual instance of the large numbers of these animals occasionally consumed by fish is shown in an examination of the digestive tract of a single adult individual of *Catostomus commersonii* (Lacépède) from the strip-mine area near Oakwood, Illinois. The ostracods, which completely packed the digestive tract to the exclusion of almost all other kinds of food, included no less than six species, three of which predominated in numbers.

Not only may ostracods be considered economically as potential links in food chains but they are also of interest because often they serve as intermediate hosts for some of the Acanthocephala, especially those which parasitize fish. As an example of an Acanthocephalan life cycle in which an ostracod is the intermediate host is the life cycle of *Neoechinorhynchus cylindratus* (Van Cleave 1913) as worked out by Ward (1940). *N. cylindratus* as an adult parasitizes the large-mouth black bass and has as the first intermediate host *Physocypria globula* Furtos 1933 (= *P. pustulosa* (Sharpe 1897) G. W. Müller 1912). In examining thousands of ostracods mounted on slides, the present writer has found several species infected with Acanthocephala. In material from permanent lakes and streams, the percentage of infection may run from one to one and one-half per cent. While this incidence of infection is not high, it shows the possibilities of securing material for working out life histories in the Acanthocephala. Since many of the primary and secondary intermediate hosts of Acanthocephala are fishes, all stages of the parasite are readily available, and infection experiments may be conducted without great difficulty.

Besides being of distinct economic importance, the ostracods are biologically interesting. Concerning the ostracods in American fresh waters, little is known of the habitats, the factors which govern distribution, or the ecological associations of which they may play an integral part. The present writer has attempted to bring together field data regarding the habitat relationships of the ostracod species of Illinois. The variability shown by various species of ostracods also merits detailed inquiry. The

most noticeable variations are in color, size, and shape of shell and the number and degree of development of tubercles along the shell margin. There is some indication from the field data that the shell color in some species, as *Cypridopsis vidua,* may be correlated with the season and the amount of algae available in the water. Whether or not an abundance of green plant material used as food causes a deepening of the shell color must be determined experimentally. The possible development of races in various local areas is a problem of academic significance. Certain available records of discontinuous variations, such as the number of tubercles along the shell margin in *Physocypria pustulosa,* lend themselves to numerical consideration. Consequently, they may be conveniently used in detecting the presence of isolated races differing from each other in the number of tubercles. Such studies may lead in time to the final settlement of the status of certain questionable species based on differences which are possibly only expressions of individual variation and which appear to the writer to be of less than subspecific importance.

The writer, recognizing the difficulties involved in the identification of ostracods and the lack of knowledge regarding their biology, has attempted herein to make a contribution of such a nature that ecologists, fresh-water biologists, and zoologists in general may have available a workable treatise by which they can, in the first place, identify species occurring in Illinois and, in the second place, gain some insight into the biology of the species found in the state. Paleontologists, who are now giving much attention to the study of fossil forms, may find the information given herein useful in the interpretation of fossil faunas of fresh-water ostracods. It is hoped that the order Ostracoda may continue to be the subject of additional investigation, since direct and detailed information regarding the life histories of most Illinois species is extremely meager, data on the distribution of many species in some parts of the state are entirely wanting, and few physiological and experimental studies have been reported in the literature.

REVIEW OF THE LITERATURE

History of Basic European Work on Ostracods.—The ostracods of North America are little known in comparison with the relative completeness of the knowledge of European forms. Since American workers have followed closely the schemes provided by European writers, a survey of classical European works is considered essential to a study of ostracods indigenous to America. Several comprehensive works have been published on the ostracods of European countries, and complete faunal lists have been very accurately compiled. A comparison of the literature relative to American forms and that concerning European species shows distinctly

that the knowledge of ostracods in America is thirty or forty years behind that in Europe.

The first important publication on ostracods was that of O. F. Müller, in 1785, entitled "Entomostraca seu Insecta testacea, quae in aquis Daniae et Norvegiae reperit, descripsit et iconibus illustravit." Between the beginning and middle of the nineteenth century, several important European papers appeared. These included a work by Jurine in 1820 on the ostracods in the vicinity of Geneva; a doctor's dissertation by Zaddach in 1844 concerning the ostracod fauna of Prussia; and Lilljeborg's publication in 1853 on the ostracod species of Scandinavia. These studies were largely taxonomic in scope. In 1854, Zenker published his "Monographie der Ostracoden," a publication of eighty-seven pages which included not only a taxonomic but also a biologic consideration of the known ostracods. The first important publication in English was written by Brady, appearing in 1868 under the title "A Monograph of the Recent British Ostracoda." With Norman in 1889, Brady published "A Monograph of the Marine and Freshwater Ostracoda of the North Atlantic and of North-Western Europe. Section I. Podocopa." Two years later, Vávra (1891) monographed the ostracods of Bohemia. In 1900, two very important comprehensive papers were published, one by Kaufmann (1900a) on the "Cypriden und Darwinuliden der Schweiz" and the other by G. W. Müller under the title "Deutschlands Süsswasser-Ostracoden." Early in the present century, G. W. Müller (1912) brought out his summarizing volume on ostracods as a part of the series "Das Tierreich." Up to the present time, this has remained the only authentic and comprehensive world-wide monograph on the ostracods, and it is still the basic publication for anyone beginning taxonomic work in the group. Among recent monographs of the ostracods of European countries have been those of Alm (1916) on the fresh-water ostracods of Sweden and of Sars (1928) on the ostracods of Norway. More recently Wagler (1937) has published a comprehensive work on European ostracods in his volume on Crustacea in the series entitled "Die Tierwelt Mitteleuropas," and Klie (1938a) has published a monograph on German ostracods in the series "Die Tierwelt Deutschlands und der angrenzenden Meeresteile." While these major publications have been appearing from time to time, there has been an influx into the periodical literature of smaller papers concerned with the taxonomy, morphology, or ecology of a small group of ostracods or the ostracods of a local area.

Comprehensive works on the biology of the ostracods are not so plentiful as those concerned primarily with taxonomy. In many of the taxonomic papers, however, some reference is made to the general biology of the species under consideration. For instance, Zenker's monograph in 1854 included much data of a biological nature as a background for the

taxonomic portion of the publication. Wohlgemuth (1914) and Alm (1916) were among the first to write in detail on the biology of the ostracods of a definite region, Wohlgemuth working on the ostracods of Saxony and Bohemia and Alm on those of Sweden. While G. W. Müller (1927) wrote a general account of ostracods in the Kükenthal-Krumbach "Handbuch der Zoologie," the most complete account of the biology as well as the anatomy and development of fresh-water ostracods is the account by Klie (1926a) in the series "Biologie der Tiere Deutschlands." This publication is applicable to forms from the United States as well as German species, because many of the species from the two countries are identical or closely related.

History of the Study of American Ostracods.—Compared with the attention which has been given ostracods by European writers, the meager work by Americans has consisted chiefly of small, scattered papers. With the exception of Klugh's (1927) work on the ecology of a few Canadian species, these papers are chiefly only of taxonomic or zoögeographical importance. The earliest publication on the ostracods of North America is the description by Haldeman (1841) of two new species of "Cypris" from Pennsylvania. The same author (1842a, 1842b) gave descriptions of two more new "Cypris" from Pennsylvania and one from Massachusetts. These ostracods were so inadequately described that their real identity is unknown, and they are listed among the dubious species by G. W. Müller (1912). The best known of early American workers in the field of ostracods are Herrick, Turner, and Sharpe. Herrick published several papers, of which his early ones (1879, 1882) refer in part to the ostracods of Minnesota. In these papers he described a few new species, but in some instances so incompletely that it is impossible now to recognize them. The early deficiency of knowledge of American ostracods is shown by Underwood's publication (1886) of a list of all the described ostracods from America north of Mexico. Here are listed fifteen species, many of which are now considered dubious; none of them were from Illinois. In 1887, Herrick published a list of the fresh-water and marine crustacea of Alabama. This included ten species of ostracods, of which five were described as new. Turner began publishing on ostracods in 1892 and after the appearance of several small publications (1892, 1893, 1894) concerning new species and records, he published in 1895 a work on the "Fresh-water Ostracoda of the United States," which appeared as part three of the "Second Report of the State Zoologist of Minnesota." This publication continued to be the most complete of any on American ostracods until the appearance in 1918 of Sharpe's account in Ward and Whipple's "Fresh-water Biology." Besides Herrick's and Turner's works, a few new species were described by Chambers (1877) and by Forbes (1893) from the western United States.

Shortly after the appearance of Turner's account of the "Fresh-water Ostracoda of the United States," Sharpe (1897) published an account of the ostracods of Illinois which, for his time, excelled in completeness all other state lists. His work was based on a large number of field collections. Sharpe followed this early work by a series of publications (1903, 1908, 1910) based on material collected by himself in Illinois and material from other localities deposited in the United States National Museum. His last publication (1918) was a complete and concise summary of all knowledge of American ostracods up to the time of publication.

Between 1900 and 1933, no monographic studies except that of Sharpe (1918) in Ward and Whipple's "Fresh-water Biology" appeared on American ostracods. Several American workers, however, published short papers. These papers include reports of a few species in Michigan and Nevada by Pearse (1910, 1914); lists from Rhode Island by Williams (1907) and from New Jersey by Fowler (1912); two publications on the ostracods of Massachusetts by Cushman (1905, 1907); and reports of the ostracods from western United States, chiefly Colorado, by Dodds (1908), Cockerell (1912), Blake (1931), and Brues (1932). A notable publication was that of Marshall (1903), in which was described the first Entocythere found on the gills of crayfish. During this period from 1900 to 1933, several European workers also studied material from North America. Alm (1914) published an account of the Arctic ostracods of Greenland and part of Canada. Sars, in 1926, gave an account of Canadian ostracods, chiefly from southeastern Canada. Klie (1931a) published an article which included three new species of ostracods from Indiana. In 1914, Weckel compiled a list of all the "free-swimming" ostracods of North America, with keys for their identification.

A new era has begun in the last decade with the publication by Furtos in 1933 of a complete survey of the ostracod fauna of Ohio. She followed this in 1935 by an article on the fresh-water ostracods of Massachusetts and in 1936 by two articles, one (1936a) on ostracods of Florida and North Carolina and another (1936b) on the ostracods from the cenotes of Yucatan and vicinity. More recently, Dobbin (1941) has published a comprehensive survey of the ostracods of the northwest coast region of the United States. At the present time, there are few investigators working on ostracods in the United States, and the field is open for taxonomic and ecological studies, especially those of state-wide significance.

Reports on the Ostracod Fauna of Illinois.—Sharpe published the first work on the ostracods of Illinois in 1897. In this publication, Sharpe listed twenty-two species, twelve of which were thought by him to be undescribed. With the exception of two of the reported twenty-two

species, all of them were from Illinois, chiefly from the vicinity of Havana, Mason County, Illinois where the Biological Station of the University of Illinois was located. A few of the twenty species in this initial publication are considered synonyms by the present writer, but seventeen of them are retained as valid. The writer has failed, however, to rediscover five of those listed by Sharpe in this early work.

Sharpe followed his first paper by three others, all of which have some reference to Illinois ostracods. Sharpe's works of 1903 and of 1910 reported little except a few additional references as far as Illinois is concerned, but his publication of 1908 contains the first records of five additional species from Illinois, one of them previously undescribed. Three of these five have not been rediscovered by the present writer. Only three other publications are available with reference to the ostracod fauna of Illinois. One of these is the reference by Kofoid (1908) to several species in the Illinois River at Havana, Illinois. The second is the mention of five species from the Chicago area by Shelford (1913). Neither of these reports contain important new records for the state, but they merit mention here as two of the few instances where ostracods found during the course of an extensive ecological investigation were carefully determined to species. Identification in both of these papers was by Sharpe. The third paper is a publication by the present writer (1942) in which are described two new species of Entocythere epizoic on crayfishes from Illinois.

Since the time of Sharpe, no one has published the results of any studies on the free-living ostracods of Illinois. The present writer has, by a study of 713 field collections from sixty-six counties, raised the total of reported free-living species from Illinois to thirty-nine. Of these, thirty-one have been seen by the present writer, while eight were reported by Sharpe but not found during the course of the present investigation. This lack of rediscovery is perhaps the result of two factors: (a) a scarcity resulting from the localized or limited seasonal occurrence of certain species (this is undoubtedly the case with *Cyprois marginata,* which was reported by both Sharpe (1908) and Shelford (1913) from a pond in Jackson Park, Chicago); and (b) an erroneous or incomplete description or one based on abnormal individuals, which has made redetermination impossible. Many of the species not found by the present writer in his collections will certainly be rediscovered when additional collections have been made, since some species are rarely observed, as, for instance, *Darwinula stevensoni* and *Notodromas monacha,* each of which is represented in the present writer's collections by a single individual.

The thirty-nine free-living species reported herein as occurring in Illinois include eleven species described as new to the literature. Seventeen of the thirty-nine species are new records for Illinois.

The following list is a summary of all records concerning free-living ostracods in Illinois.* In previous reports, species have been recorded often under names which have required some change to bring the nomenclature up to date. For the names used by earlier writers in reporting ostracods from Illinois, the reader is referred to the synonymy under the taxonomic discussion of each species. Here the writers reporting Illinois records are indicated by numbers in parenthesis after the name of each species, as follows: (1) Sharpe 1897; (2) Sharpe 1903; (3) Sharpe 1908; (4) Kofoid 1908; (5) Sharpe 1910; (6) Shelford 1913; (7) the present writer.

Suborder Podocopa *s. str.*
Family Cypridae
Subfamily Candoninae *s. str.*
Genus Candona Baird 1845
C. simpsoni Sharpe 1897 (1, 4, 7)
C. punctata Furtos 1933 (7)
C. fluviatilis sp. nov. (7)
C. albicans Brady 1864 (7)
C. biangulata sp. nov. (1, 7)
C. crogmaniana Turner 1894 (7)
C. sigmoides Sharpe 1897 (1, 4, 7)
C. recticauda Sharpe 1897 (1)
C. sharpei sp. nov. (1)
C. caudata Kaufmann 1900 (7)
C. distincta Furtos 1933 (7)
C. indigena sp. nov. (7)
C. suburbana sp. nov. (7)
C. acuta sp. nov. (7)
C. fossulensis sp. nov. (7)
Subfamily Cyclocyprinae
Genus Cyclocypris Brady and Norman 1889
C. forbesi Sharpe 1897 (1, 7)
C. sharpei Furtos 1933 (3)
Genus Cypria Zenker 1854
C. turneri sp. nov. (1, 4, 6, 7)
C. mediana sp. nov. (7)
C. obesa Sharpe 1897 (1, 5, 7)
C. maculata sp. nov. (1, 4, 7)
C. ophthalmica (Jurine 1820) Brady and Norman 1889 (7)
Genus Physocypria Vávra 1897
P. pustulosa (Sharpe 1897) G. W. Müller 1912 (1, 4, 7)
P. dentifera (Sharpe 1897) G. W. Müller 1912 (3)
Subfamily Ilyocyprinae
Genus Ilyocypris Brady and Norman 1889
I. gibba (Ramdohr 1808) Brady and Norman 1889 (7)
I. bradyi Sars 1890 (7)
Subfamily Cyprinae *s. str.*
Genus Cypricercus Sars 1895
C. tuberculatus (Sharpe 1908) *comb. nov.* (3, 7)

*Two additional species of ostracods, *Entocythere illinoisensis* Hoff 1942 and *E. copiosa* Hoff 1942, have been reported as living in the gill chambers of crayfishes in Illinois (Hoff, 1942). Since these species are epizoic, they are excluded from this list.

C. fuscatus (Jurine 1820) Sars 1928 (1, 3, 6)
C. reticulatus (Zaddach 1844) Sars 1928 (1, 3, 6, 7)
Genus Cyprinotus Brady 1885
C. incongruens (Ramdohr 1808) Turner 1895 (1?) (7)
C. pellucidus Sharpe 1897 (1, 2)
Subfamily Notodrominae
Genus Notodromas Lilljeborg 1853
N. monacha (O. F. Müller 1776) Lilljeborg 1853 (3, 6, 7)
Genus Cyprois Zenker 1854
C. marginata (Strauss 1821) Zenker 1854 (3, 6)
Subfamily Cypridopsinae
Genus Cypridopsis Brady 1867
C. vidua (O. F. Müller 1776) Brady 1867 (1, 4, 6, 7)
Genus Potamocypris Brady 1870
P. smaragdina (Vávra 1891) Daday 1900 (1, 7)
Family Darwinulidae
Genus Darwinula Brady and Norman 1889
D. stevensoni (Brady and Robertson 1870) Brady and Norman 1889 (7)
Family Cytheridae
Subfamily Limnocytherinae
Genus Limnocythere Brady 1867
L. reticulata Sharpe 1897 (1, 7)
L. illinoisensis Sharpe 1897 (1, 4)
L. verrucosa sp. nov. (7)

METHODS OF COLLECTION AND PREPARATION

The material on which this publication is based was collected by the writer during the vernal, aestival, and serotinal seasons of 1940. The collections were made in sixty-six counties of Illinois. An attempt was made to collect impartially. During most of the collecting trips, all available waters were examined, even though the habitat appeared unfavorable for ostracods. In spite of the examination of such uninviting waters, about two-thirds of the samples collected contained one or more species of ostracods. In all, 713 samples from Illinois actually containing ostracods formed the basis for this investigation.

Almost without exception, collections were made with a Birge cone net eleven inches long and four inches in diameter at the open end. The open end is fitted on a sheet-metal cylinder which is closed with a cone of coarse brass wire netting of about three-eighths inch mesh. This cylinder keeps the open end of the net from collapsing and the wire netting prohibits the net from collecting an assortment of vegetation and debris. The organisms are caught in a half-ounce bottle attached to the apex of the net. The entire net with the metal cylinder at the larger end and the collecting bottle at the apex is mounted on a toboggan made of galvanized sheet metal, the cylinder being firmly attached to the sled at the forward end. The collecting bottle lies on the sheet-metal sled and

when in use is held in place by rubber bands fastened through two small holes in the bottom of the sled. This holds the net approximate to the sled at all times and keeps it stretched out in a cone. The adaptation of this apparatus was suggested by the description of the plankton trawl described by Galtsoff (1937). It was found that this net could be dragged on the bottom or through vegetation and roots as well as against rocks without fouling or injury to the net. Samples were made from all kinds of habitats and often several samples were taken from the same general locality in order to include the several available habitats and detect, if possible, any habitat relationships. Each time after using, the net as well as the bottle was washed with as clear water as was obtainable, and from the nature of the samples it is obvious that such washing, even though in the same water from which samples were taken, was effective and individuals were not carried over in the net to contaminate the next sample. In instances where clear open water was not available for washing the net, it was well rinsed just before using in water from which the next collection was to be made.

While quantitative methods are generally recognized as desirable in taking plankton samples, the habitats in which ostracods are to be found preclude the possibility of adapting quantitative methods in the sampling carried on in the present investigation. The cone net is the only apparatus by means of which adequate samples of water could be strained from weedy ponds, algal mats, and the water immediately over mud bottoms where ostracods are abundant. Perhaps following the same historical development as that through which plankton studies in general have gone, the strictly qualitative methods essential in the present survey may be supplemented at a later date by quantitative methods for given habitats or for limited groups of species. At least for the present the writer felt that the infrequence of occurrence of some species in the numerous qualitative samples gives justification for relying on relatively numerous qualitative samples for the initial faunal survey.

At the same time as the samples were taken, a record was made of the date, location, and certain physical factors as the kind of habitat, the force of the current, if any, the nature of the bottom, and the turbidity of the water. In some instances, the hydrogen ion concentration was determined with a LeMotte comparator, using bromthymol blue as an indicator. On making each collection, the associated vegetation was noted in considerable detail in order to learn whether or not there might be a correlation between the presence of certain species of ostracods and the kind of vegetation present. These data were entered in a permanently bound field notebook under a collection number and the date. In the jar containing the sample, there was placed a paper on which was written the date and number of the collection. After examination in the laboratory, all

the collections containing ostracods were given serial numbers and the field data were transferred to notebooks listing each collection by its serial number.

After making the collections by running the net through the vegetation, along the bottom, or on the surface, as the case might be, the sample was poured from the collecting bottle on the net to a four-ounce ointment jar. Collections were usually allowed to accumulate until noon and night, when they were preserved by the addition of 95% ethyl alcohol in an amount equal to the volume of the sample. When the temperature was very high, it was found necessary to preserve the samples more often than twice a day because of the biolytic action of the temperature on some of the organisms. The killing of the ostracods by the addition of an equal volume of 95% ethyl alcohol to the sample is to be recommended. If formalin is added or the animals are dropped into an alcohol of high concentration, many of the animals close the shell tightly, and it is then difficult to remove the valves for examination of the appendages. When killed by adding the alcohol as explained above, the individuals in most species are killed with the shell gaping. If the samples are to be kept for some time before the ostracods are separated from the other material, it is well to raise the concentration of the alcohol to about 85% by pouring off the supernatant alcohol and refilling the jar with a sufficient amount of 95% alcohol. Formalin may be used as a preservative, but the appendages become stiffened and dissection is made more difficult. Care must also be taken in the use of commercial formalin, since much of the commercial solution is not acid-free, and the samples will gradually deteriorate through decalcification of the shells.

After sorting out the material in the collections, representatives of the species in each sample were usually mounted permanently for study. This was necessary for the checking of the identification of many of the species, although it did involve considerable labor and materials. Even though a few common species such as *Cypridopsis vidua* and *Potamocypris smaragdina* are recognizable under the binocular dissecting microscope, the writer made a series of slides of such common forms in order to verify the identification and discover, if possible, whether or not races occur in different localities. While it may seem a waste of energy to mount hundreds of individuals of common and easily recognized species, it is the only way in which limits of the variation of a species can be determined. By knowing the limits of variation, one may avoid describing as new the ultimate ends of a series representing a single species.

Two methods were used in making slides. It was found that glycerine mounts were convenient and these were used in some instances. A slide is ringed with several layers of gold size or asphaltum and the ostracod, after being cleared in glycerine, is dissected in a drop of glycerine on the

slide within the ring. A cover slip is then placed over the dissection and sealed with material similar to that used in making the initial ring. While this is a rapid way of making slides and shows the finer structural details to good advantage, it has several disadvantages. Among these might be mentioned the poor preservation of material and lack of permanency in contrast to mounting media such as diaphane or balsam; the lack of any staining to bring out certain structures; and the impossibility of mounting most shells in this way because of their size. This last makes necessary a separate mounting of shells in some other medium under a second cover to the side of the glycerine mount. Since the mounting of the shell is necessary to keep shell and soft parts together and avoid loss of the former, and since in this method of mounting, the shell has to be dehydrated for mounting in balsam or diaphane, it is just as convenient to dehydrate the entire animal and mount in some one of the more nearly permanent media.

The most satisfactory mounts of ostracods are made by staining with acid fuchsin. The ostracods are removed from the preserving alcohol and placed in a LeFevre embryological watch glass in which they are run through lessening concentrations of alcohol to water. They are then washed in a small amount of 1/50-N solution of hydrochloric acid for about one minute. After pipetting off the acid water, a 0.5% aqueous solution of acid fuchsin is placed in the watch glass and the animals are allowed to remain in this stain from one to five hours depending on the species and perhaps, to a larger degree, on the recency of molting, since newly molted ostracods seem to stain more favorably than the exuviae or animals long molted. After staining, the acid fuchsin solution is removed with a pipette and the material washed rapidly several times in a 1/50-N solution of hydrochloric acid. The hydrochloric acid solution appears to intensify the stain. Overstaining seldom occurs, but destaining, if necessary, may be carried out by washing the material in alkaline tap water or slightly alkalinized alcohol. The material, after washing in acid water, is run through the alcohol series to absolute alcohol. Since the alcohol is pipetted off after each treatment and the watch glass retains a small amount of the solution, it is well to wash at least twice with alcohols of each grade, especially of the higher concentrations. If mounting is to be done in balsam, the material dehydrated in alcohol is cleared in xylol (at least three changes). The cleared animal is placed in a drop of balsam on a slide under the binocular and the shell removed by the use of fine needles. The shell halves are removed to a second drop of balsam on the same slide and covered by a slip supported by bits of broken glass or pieces of capillary tubing of the appropriate diameter. The appendages are then isolated in the first drop of balsam and a cover slip added without any support, since it is necessary to have a thin mount in which

the appendages are extended as much as possible in one plane. By leaving the cover unsupported, it is possible to use an oil immersion lens for the observation of fine setae and serrations. As the shells and soft parts take up but little room on the slide, it is often possible to use circular cover slips only one-fourth of an inch in diameter. If more than one animal is mounted under a single slip, it may be necessary to employ larger covers.

A more successful mounting method has been the bringing of stained material into diaphane directly from absolute alcohol. The principal advantage of this procedure is the elimination of one of the steps, that of clearing, thus saving time and materials and avoiding the hardening action of the clearing fluid. The dissection of material which has not passed through any of the usual clearing fluids is more easily accomplished than it is in material cleared in such fluids. The diaphane clears the material sufficiently for good observation, a partial clearing really being much more adequate than clearing in xylol or some other clearing reagent in which the animals become so transparent that some of the finer structures cannot be clearly observed. In mounting in diaphane from absolute alcohol, care must be taken to use several changes of the alcohol in order to completely dehydrate the material. To avoid the passing of alcohol into the diaphane, the material should be placed on the end of a slide in as small a drop of alcohol as possible and the alcohol removed by absorption with a small piece of filter paper. The animal is then transferred to the diaphane with a needle. Dissection may be carried out just as in balsam-mounted ostracods, and the valves, if large, are mounted under a separate cover. Sometimes it is advantageous to keep the soft parts intact after removal from the shell in order to be able to orient properly the various parts of the animal.

BIOLOGY OF ILLINOIS OSTRACODS

Habitats

If sufficient search is made, there will be found scarcely a single kind of aquatic habitat in which ostracods are not found. Since the state of Illinois is entirely an inland state, no mention need be made here to the biology of the ostracods living in brackish or marine waters.

The habitats investigated by the present writer include many kinds of still and running waters. These have been grouped for convenience into four types: (1) temporary still waters, including all vernal or temporary ponds whether old ox-bows, prairie and forest pools, roadside ditches, or small water-filled depressions; (2) permanent still waters, including lakes both artificial and natural, swamps which do not dry up

during the aestival or serotinal seasons, and the lake-like backwaters of large rivers; (3) temporary running waters and the pools left in stream beds after the stream has ceased to flow; and (4) permanent streams of all sizes. Each one of these habitats presents a variety of ostracod species, but the running waters have fewer species than the still waters. The only habitat investigated by the writer in which large numbers of several species did not occur were the waters extremely high in organic material such as some of the cypress swamps in southern Illinois.

Certain habitats have not been investigated because of lack of time and facilities. No attempt was made to explore the ostracod fauna of Lake Michigan, since the lake presents certain problems which make it somewhat separate from the remainder of the state as far as the collector is concerned. It was also impossible to visit tamarack bogs in the northern part of the state since these have been closed to the public. A habitat which will no doubt prove fruitful when investigated is that of underground waters. A large number of species, chiefly of the genus Candona, have been described from wells, springs, and cave waters in Europe by Kiefer and Klie (1927), Klie (1934, 1936, etc.), and others. That possibilities are present in Illinois for a study of subterranean species is shown by the report of Klie (1931a) of some species from the waters in an Indiana cave. The water of crayfish burrows also merits examination. Creaser (1931) reported *Cypria exsculpta* (? = *Cypria turneri sp. nov.*) abundant in the burrows of the crayfish *Cambarus diogenes* in Missouri, and the present writer has taken a few species of ostracods from a similar habitat in Illinois.

After a detailed survey of the various species of ostracods, it was found that certain species could be classified as occurring in temporary or permanent and still or running waters. The minor subdivisions of the four types of habitat already suggested have no significance as far as the biology of the ostracods is concerned; and, indeed, the kinds of associations in a given habitat seem to limit but little the distribution of particular species. Thus the same species may be found along the margin of a large lake regardless of whether the sample is taken in masses of algae, decaying grass, different species of aquatic spermatophytes, or even from bottom practically devoid of vegetation. In the same manner, the species found in a small stream usually vary little whether taken from masses of algae or in mats of plants or whether the collection is made in a quiet pool or in an area where the water is flowing. The sum total of the factors which are found expressed in the four types of habitats listed appears to determine to a large degree, and with few exceptions, the species of ostracods present. Thus the independent factors such as type of bottom, current, and associated vegetation determine only to a minor degree the distribution of most species.

TABLE 1

Table showing the incidence, expressed in percentages, of each species observed by the writer in temporary and permanent, still and running waters. The name of each species is followed by the number of collections in which it occurred.

Species	Collections	Still waters		Running waters	
		Temp.	Perm.	Temp.	Perm.
Candona distincta	3	100	..	..	..
Candona indigena	4	100	..	..	..
Candona suburbana	2	100	..	..	..
Candona fossulensis	2	100	..	..	..
Cypria ophthalmica	9	44	56	..	..
Cypricercus reticulatus	31	87	..	13	..
Candona biangulata	4	50	..	50	..
Candona albicans	4	25	..	75	..
Cypria turneri	29	48	38	7	7
Candona simpsoni	83	39	26	23	12
Cypria obesa	9	33	45	11	11
Cypridopsis vidua	505	20	48	10	22
Limnocythere reticulata	69	16	2	54	28
Cyprinotus incongruens	16	13	6	44	37
Cypria maculata	43	12	42	9	37
Physocypria pustulosa	175	8	78	4	10
Potamocypris smaragdina	118	6	41	11	42
Ilyocypris gibba	44	4	2	49	45
Ilyocypris bradyi	71	1	4	47	48
Limnocythere verrucosa	4	..	100	..	..
Darwinula stevensoni	1	..	100	..	..
Notodromas monacha	1	..	100	..	..
Cypricercus tuberculatus	3	..	100	..	..
Cyclocypris forbesi	1	..	100	..	..
Candona crogmaniana	2	..	100	..	..
Cypria mediana	3	..	33	67	..
Candona caudata	3	..	33	33	33
Candona punctata	1	..	..	100	..
Candona fluviatilis	3	..	..	100	..
Candona acuta	5	..	..	80	20
Candona sigmoides	4	..	..	..	100

The frequency with which ostracods may be collected without regard to bottom or vegetation throughout a given pond, lake, or stream may be shown by the following two examples taken from many similar instances in the writer's data:

(1) On June 4, 1940, four samples were taken from Twin Lakes at Paris, Edgar County, Illinois. One sample was made from a mass of old leaves in water eight inches deep over a mud bottom where there was no aquatic vegetation or algae; a second collection was made in water of about the same depth where there were many aquatic plants and considerable algae; a third sample was taken above a rock bottom in mixed algae and decaying vegetation; and the last was a surface sample where the water was two feet deep. Each of the four samples contained the following three species: *Cypridopsis vidua, Potamocypris smaragdina,* and *Physocypria pustulosa.*

(2) In three samples taken from a drainage ditch near Rantoul, Champaign County, Illinois, on June 20, 1940, *Limnocythere reticulata* was found abundant. The samples were taken as follows: the first from a backwater area with decaying corn stalks over a silt bottom; the second from along the edge of the stream in grass overhanging the mud bank where there was some current; and the third was from masses of algae clinging to the gravel bottom of a pool under the highway bridge.

While the distribution in any habitat of most of the species present is very general, some species, as many Candona species, are sometimes found isolated in definite regions. No logical excuse for such localization has appeared in the writer's data. A detection of many of the minor environmental factors which play a rôle in distribution probably will be discovered only by detailed laboratory experimentation. It is safe, however, to state that in general the more common species are limited in their habitat range only by the generalized conditions expressed in still temporary waters, permanent still waters, temporary running waters, and permanent running waters or by much finer analysis of environmental conditions than has even been possible in field studies. The distribution of species according to the type of habitat is shown in Table 1. By reference to the table, it will be seen that there are certain species apparently characteristic of each of the four types of habitats, others which occur in combinations of two or three habitats, and some that are found in all the types of habitats. While there is a fair degree of consistency in habitat relations for many of the species, the association is not absolute. In the same manner that species serve as index organisms in other biological phenomena, these species are not always immutable indices to specific habitat conditions. The kinds of habitats or combination of habitats with the characteristic ostracod species* of each may be listed as follows:

(1) Ostracods chiefly of vernal ponds:

Candona distincta	*Candona fossulensis*
Candona indigena	*Cypricercus reticulatus* (usually)
Candona suburbana	

(2) Ostracods chiefly of permanent lakes:

Candona crogmaniana	*Notodromas monacha*
Cyclocypris forbesi	*Darwinula stevensoni*
Physocypria pustulosa (usually)	*Limnocythere verrucosa*
Cypricercus tuberculatus	

(3) Ostracods typical of temporary streams:

Candona punctata	*Candona fluviatilis*

(4) Ostracods typical of permanent running waters:

Candona sigmoides

(5) Ostracods found in both temporary and permanent still waters:

Cypria ophthalmica

*Because of the incompleteness of the data of former workers, only those ostracods are shown here that were actually observed by the writer in the course of his field work. What is known regarding the ecology of any other species recorded for Illinois may be found under the species description.

(6) Ostracods collected chiefly in both temporary and permanent running waters:

Candona acuta	*Cyprinotus incongruens*
Ilyocypris bradyi	*Limnocythere reticulata*
Ilyocypris gibba	

(7) Ostracods found in temporary still and running waters:

Candona albicans	*Candona biangulata*

(8) Species found in three or more kinds of habitats:

Candona simpsoni	*Cypria obesa*
Candona caudata	*Cypria maculata*
Cypria turneri	*Cypridopsis vidua*
Cypria mediana	*Potamocypris smaragdina*

Except for the species which have been taken in but one or two collections, little change in the knowledge of the habitat of any species should be effected by additional collections. At the same time, many of the records based on a single sample are no doubt accurate, since they represent species which are known to be limited in their range of habitat.

Physical Factors in the Habitat

While the distribution of ostracods appears to be limited grossly by the type of habitat rather than certain single isolated environmental factors, there is a slight correlation between some of the physical factors and the occurrence of certain ostracod species. According to P. R. Needham (1938), there are five physical conditions which largely determine the distribution of aquatic organisms. These are (1) type of bottom; (2) velocity of current; (3) depth of water; (4) temperature of water; (5) materials in suspension and solution. Of these factors, two were recorded in considerable detail in the field notes. These were (1) type of bottom and (2) the amount of current. Since most of the collections were made from shallow ponds and streams and from the littoral zone of the larger bodies of water, the depth showed no distinguishable effect on the distribution. Roughly speaking, the writer's experiences in the field seem to indicate that the limited temperature ranges found in Illinois also have little effect on the distribution of species of ostracods. Although some species are inhabitants of cool vernal ponds or the larger, cooler lakes of northern Illinois, there seems to be, offhand, no indication that water temperature is in any way causal to the distribution of ostracod species. The effect of temperature on the life cycle and activities of ostracods can, perhaps, best be approached from an experimental point of view before any definitive effect can be ascertained under natural conditions. As a result of the limited time allowed for this study and the difficulty of carrying and using elaborate apparatus which would have hindered the rapidity necessary for collection of a large number of field samples, no effort was made to test the turbidity of the water or to determine the materials in solution. The hydrogen ion concentration,

however, was determined on about one-fourth of the samples secured. No more tests were made since, as a rule, the waters of the northern two-thirds of the state are alkaline. A number of tests were made to check the character of the water in the southern portion of the state where it is often acid especially in Franklin, Johnson, and Massac Counties.

Kind of Bottom.—In regard to the effect of the type of bottom on the occurrence of ostracods, no very definite correlation has been found in most species, and the distribution appears usually to be random as far as the type of bottom is concerned. As the proportionate number of times in which a species was found associated with different types of substratum was usually about the same as the number of times samples were taken from the same type of substratum, no correlation between range and type of bottom is evident in most cases. Many of the Candona species show a slight correlation with the type of bottom, a more-than-average number of collections being made on a mud bottom for many of the species. This is related, no doubt, to the occurrence of many Candona species in temporary waters where mud is usually the substratum encountered. Besides, most of the Candoninae crawl on the bottom, and mud is more favorable for animals of such a habit than is a sand bottom. Three species besides those of the genus Candona show a tendency to be associated with a particular type of bottom. These species are listed below with the percentages of incidence over various substrata along with the percentage for comparison of each type of substratum in the total number of collections.

	Mud	*Hard clay*	*Sand and gravel*	*Rock*
Cypricercus reticulatus	100%	0%	0%	0%
Cyprinotus incongruens	59	0	35	6
Potamocypris smaragdina	49	5	36	10
Average of all collections	73	4	19	5

Since all thirty-two of the collections of *Cypricercus reticulatus* were found over a mud bottom, it is obvious that this species is somewhat similar to the Candona species already mentioned. Like many of the Candoninae, this species is an inhabitant of temporary waters. Why there should be an increase over the average of incidence in the case of *Cyprinotus incongruens* on a sandy bottom is not known, but in the case of *Potamocypris smaragdina* the increase of a sand and gravel bottom as a substratum may be the result of this species occurring in great abundance in permanent waters where sand and gravel shores are common. Hence the type of bottom is a limiting factor in very few species but rather an incidental factor related to the habitat in general.

Current.—In contrast to the relegation of the type of bottom to a minor position as a factor in the distribution of ostracods, there is a marked relationship between the velocity (as measured by inspection

TABLE 2

Table showing incidence, expressed in percentages, of each species observed by the writer in varying conditions of current. The name of each species is followed by the number of collections in which it occurred.

Species	Collections	No current	Little current	Much current	Swift current
Candona punctata	1	100	..	..	..
Candona crogmaniana	2	100	..	..	..
Candona distincta	3	100	..	..	..
Candona indigena	4	100	..	..	..
Candona suburbana	2	100	..	..	..
Candona fossulensis	2	100	..	..	..
Cyclocypris forbesi	1	100	..	..	..
Cypria mediana	3	100	..	..	..
Cypria ophthalmica	8	100	..	..	..
Cypricercus tuberculatus	3	100	..	..	..
Notodromas monacha	1	100	..	..	..
Darwinula stevensoni	1	100	..	..	..
Limnocythere verrucosa	4	100	..	..	..
Cypria obesa	9	78	22	..	..
Candona biangulata	5	60	40	..	..
Candona albicans	4	75	..	25	..
Candona caudata	3	67	..	33	..
Cypria turneri	28	94	3	3	..
Physocypria pustulosa	172	92	7	1	..
Cypricercus reticulatus	30	90	7	3	..
Cypria maculata	42	64	24	12	..
Cyprinotus incongruens	16	31	38	31	..
Cypridopsis vidua	500	80	16	3	1
Candona simpsoni	84	79	14	5	2
Potamocypris smaragdina	117	68	30	1	1
Limnocythere reticulata	70	50	26	20	4
Ilyocypris gibba	42	27	48	18	7
Ilyocypris bradyi	72	26	44	24	6
Candona acuta	5	20	40	20	20
Candona fluviatilis	3	..	100	..	..
Candona sigmoides	4	..	50	25	25

only) of the flow or the absence of current and certain ostracod species. From Table 2 it may be observed that while most of the species investigated are abundant in quiet water, many of these same species tolerate varying rates of flow. Certain species, however, are confined almost without exception to water in which there is no current. Although the number of collections of most Candona species are relatively few, there is considerable evidence that the following species are chiefly confined to quiet waters: *C. crogmaniana, C. distincta, C. indigena, C. suburbana,* and *C. fossulensis.* Three species of Cypria, *C. turneri, C. mediana,* and *C. ophthalmica,* belong also in habitats in which there is no current. *Cypricercus tuberculatus, Notodromas monacha, Darwinula stevensoni,* and *Limnocythere verrucosa* have been taken only from the still waters of northern lakes. Two common species, *Physocypria pustulosa* and *Cypricercus reticulatus,* are seldom taken from flowing waters. Areas which are

subject to considerable wave action appear to be no different as far as the ostracods are concerned than areas of quiet water. This is easily conceivable since many of the ostracods live in the plant zone where the action of the waves is not pronounced.

While certain species of ostracods are found usually in quiet waters, other species occur more abundantly in flowing waters. *Candona fluviatilis, C. sigmoides,* and *C. acuta* are common in running water, the last two species sometimes being found where the flow is swift. Among the species most typical of streams are *Ilyocypris gibba, I. bradyi, Cyprinotus incongruens,* and to some extent *Limnocythere reticulata.* A few species which are usually found in still water, are frequent also in a little current and some may even tolerate swiftly flowing water at times, especially during flooded conditions. Two of these, *Cypridopsis vidua* and *Potamocypris smaragdina,* sometimes are found in rapidly flowing water, although they are more abundant where there is no current.

The velocity of flow is no doubt a limiting factor in the distribution of many ostracod species. Many of the forms living in areas where considerable current is found are adapted by having the antennae modified for creeping rather than swimming. A rather large shell, rectangular, compressed, and sometimes ornamented by furrows or protuberances seems to be characteristic of species living in running waters. On the other hand, active swimmers as most of the Cypria species, *Cypridopsis vidua, Physocypria pustulosa,* and *Potamocypris smaragdina* seem adapted to quiet water, since they have well developed swimming setae, often tumid shells, and have little ability to maintain themselves against strong currents.

Hydrogen Ion Concentration.—The only other physical factor given consideration in the field was the hydrogen ion concentration. Most species do not appear to tolerate waters which are strongly acid in reaction. This is especially true of the species with large, heavily calcified shells. Such forms, as many of the Candona species, *Cyprinotus incongruens,* and the two Illinois species of Ilyocypris are included in this group. On the other hand, many of the Cypria species tolerate acid conditions, and these include for the most part species which have small shells apparently protected by a heavy organic covering as evidenced by color and texture. Many of the Cypria forms as well as *Physocypria pustulosa* and *Cypridopsis vidua* fall into this group. Because of the acid nature of the water in the extreme southern part of Illinois, the writer believes that the absence there of many species elsewhere common may be explained on the basis of their intolerance to the acid environment. Two species of Cypria, *C. mediana* and *C. ophthalmica,* are, on the other hand, absent from the northern half of the state, and since they are forms which tolerate an acid condition, it is possible that the conditions are not

proper for their continued propagation in the highly alkaline lakes of northern Illinois.

It is regrettable that data relative to other physical factors could not have been collected for analysis, but this was impossible with the limited time available. As a result, however, it is possible to state that, on the basis of the data at hand, there are certain species of ostracods confined more or less to definite habitats and that in general the distribution of ostracods is limited, to some extent at least, by the velocity of the current and the hydrogen ion concentration of the water. Other physical factors, such as the nature of the bottom, appear to have little to do with habitat selection.

Biotic Relationships

At the beginning of this investigation, the writer held the preconceived idea that there might be species of ostracods characteristic of different plant associations and species which might be commonly associated together. The data collected in the field failed to verify either of these ideas. A few species show higher incidence, however, on bare bottom or as a constituent of plankton than do other species.

As mentioned in the introduction, ostracods are not important as plankters, in spite of the statement by Welch (1935) to the contrary. Some species, it is true, are occasionally found in open water plankton samples (Table 3), but they are of such minor importance that they are not mentioned by Eddy (1934) in his study of fresh-water plankton communities. Kofoid (1908), in one of the most intensive surveys ever made on the plankton of a river system, lists a few species found in plankton from the Illinois River at Havana, Illinois. He found *Candona simpsoni* "occasionally adventitious" in plankton samples. This is rather peculiar as the Candona species are not very natatorial, since they lack swimming setae on the antennae. Kofoid's record of this species in plankton is substantiated by the records of the present writer who has found the same species occurring as a plankter. Kofoid also reported *Cypria ophthalmica* and *Cypridopsis vidua* as common and *Cypria exsculpta* (= *Cypria turneri*) and *Cypria pustulosa* (= *Physocypria pustulosa*) as rare in plankton. He also collected a typical bottom form, *Limnocythere reticulata,* in the plankton at the time of flood waters. *Cypria turneri* and *Physocypria pustulosa* reached the highest incidence of all those species found in plankton in the writer's samples. Of these, the first was taken as a plankter in seven per cent and the second in six per cent of the samples in which they occurred. *Cypria maculata, Cypridopsis vidua, Potamocypris smaragdina,* and *Candona simpsoni* may also be taken occasionally in areas of open water. It will be noticed that the ostracod species found in plankton are, more often than not, active

TABLE 3

Table showing the incidence, expressed in percentages, of certain species found in collections from bare bottom areas, in plankton, and associated with different kinds of vegetation. The name of each species is followed by the number of collections in which it occurred. (Aqua. vege. = Aquatic vegetation (Spermatophytes); Dec. vege. = Decaying vegetation.)

Species	Collections	Bare bottom	Grass	Aqua. vege.	Alga	Dec. vege.	Plankton
Candona biangulata	5	60	40	..	..	..	..
Cyprinotus incongruens	18	11	39	..	50	..	..
Cypria obesa	11	9	37	36	18	..	..
Cypria ophthalmica	10	10	40	..	30	20	..
Ilyocypris gibba	47	15	42	6	28	9	..
Ilyocypris bradyi	77	10	35	13	29	13	..
Limnocythere reticulata	79	8	35	10	27	20	..
Cypria turneri	29	14	31	14	17	17	7
Physocypria pustulosa	188	8	19	30	31	6	6
Candona simpsoni	93	6	44	10	29	9	2
Cypridopsis vidua	537	4	30	24	30	9	3
Cypria maculata	48	2	32	20	40	2	4
Potamocypris smaragdina	126	2	21	29	40	6	2
Candona albicans	6	..	50	..	50	..	..
Cypricercus reticulatus	32	..	50	..	16	34	..
Candona acuta	5	..	20	20	20	40	..

swimmers with a small and plump shell. Certainly they do not breed in open water and are, as Kofoid states (1908), completely adventitious in plankton, since they are apparently derived from vegetation-covered areas near shore or in backwater lakes.

Candona biangulata appears to be the only ostracod found in the majority of instances on bare bottom. The factor responsible for this trait cannot, at present, be determined but may be related to food habits about which little is known. In general, the association of most species with different types of vegetation deviates little from the average for all the collections. A very limited number of species are absent from associations dominated by aquatic plants. These include *Candona albicans, C. biangulata, Cypria ophthalmica, Cypricercus reticulatus,* and *Cyprinotus incongruens.* This lack of average incidence of association with aquatic spermatophytes may be explained in some instances by the fact that *Candona albicans, C. biangulata,* and *Cypricercus reticulatus* are inhabitants only of temporary waters and as a result do not have occasion to become associated with aquatic seed plants which reach a high degree of development in permanent waters. In the same way, it is possible that *Cyprinotus incongruens* has little opportunity for more than mere chance association with such plants, since it is chiefly an inhabitant of running waters where water plants are not abundant. It is difficult, however, to

explain the absence of *Cypria ophthalmica* from the aquatic vegetation since it is entirely a species of still waters, both temporary and permanent. However it is unsafe to venture the opinion that the presence of aquatic vegetation limits the distribution, since the number of samples in the case of *C. ophthalmica* is relatively small and the range of this species does not include northern Illinois, where a majority of the collections from aquatic vegetation was made. It appears then that there is no conspicuous relationship or specific association between certain species of ostracods and certain types of vegetation other than what might be legitimately expected as incident correlations resulting from reflections of the general habitat and range of the species.

The writer gave special attention to the ostracods taken from growths of various species of aquatic plants especially in the lakes of Lake and Cook Counties in an effort to determine if any relationships existed between certain species of ostracods and specific water plants. Most of the collections used for this particular part of the study were made by Bertrand A. Wright who supplied the identification of the plants. A few examples of this type of data, showing the plants present where various ostracods were found may be assembled as follows:

(1) West Loon Lake, Lake County, Illinois; August 7, 1940:

Potamocypris smaragdina.....
Cypridopsis vidua..... } *Chara sp.*

Limnocythere verrucosa.....
Potamocypris smaragdina.....
Cypridopsis vidua..... } *Chara sp.*

Limnocythere verrucosa.....
Potamocypris smaragdina.....
Cypridopsis vidua..... } *Chara sp.* and *Potamogeton natans*

Potamocypris smaragdina.....
Limnocythere verrucosa..... } *Vallisneria sp.*

Potamocypris smaragdina.....
Cypridopsis vidua..... } *Potamogeton crispus* and *P. natans*

Potamocypris smaragdina.....
Limnocythere verrucosa..... } *Chara sp.* and alga

(2) East Loon Lake, Lake County, Illinois; August 7, 1940:

Potamocypris smaragdina.....
Cypridopsis vidua..... } *Chara sp.* and *Potamogeton natans*

Potamocypris smaragdina.....
Cypridopsis vidua..... } *Ceratophyllum sp.*

Physocypria pustulosa.....
Cypridopsis vidua..... } White water lily and *Myriophyllum sp.*

Cypridopsis vidua.....*Spirogyra sp.*

Potamocypris smaragdina.....
Cyclocypris forbesi.....
Cypridopsis vidua..... } *Chara sp., Myriophyllum sp.,* and *Potamogeton sp.*

Potamocypris smaragdina..... } *Potamogeton crispus* and *Chara sp.*
Cypridopsis vidua..... }

(3) Lake at strip-mine area, Vermilion County, Illinois; September 19, 1940:

Cypridopsis vidua..... } Alga and Sago weed
Potamocypris smaragdina..... }

Cypridopsis vidua.....*Dianthera americana*

Cypridopsis vidua.....Sargasso weed

Cypridopsis vidua.....*Ceratophyllum sp.*

These data illustrate admirably the condition found in lakes in general. The ostracod species show no distinct favoritism for certain plants and appear not to be a part of any particular association. It will be seen that in only two instances are there species in a given collection that do not occur in several other collections from the same lake on the same date. For one of these, *Cyclocypris forbesi* from East Loon Lake, this is the only time it was taken during the entire field investigation and so has little significance here, since its occurrence in the state is rare. Likewise, the presence of *Potamocypris smaragdina* in the strip-mine lake is probably insignificant as far as associations are concerned, since it is found associated with all kinds of plants in both East and West Loon Lakes.

An examination of the data was also made to determine if the species of ostracods formed associations among themselves. It was thought by the writer that such information might be useful in proving that there are certain environmental factors which govern the distribution of ostracod species. If it were possible to show that certain species of ostracods were always associated together, it would be sound evidence that environmental factors limited the distribution of groups of species reacting similarly to the same limiting factors. A close study of the incidence, in which certain species occurred together, showed no significant correlation indicative of any inter-group associations. The data are too bulky to give in detail here and too insignificant to merit detailed discussion. Apparently association of two or more species is largely by chance, except as such associations are made up of species which are characteristic of one of the four kinds of habitats already described. Thus *Ilyocypris spp.* and *Limnocythere reticulata* are often found associated together in running water.

As an incidental observation, the writer found that protective coloration appears to be well developed in many of the ostracods, especially in species of Cypria, *Physocypria pustulosa, Cypridopsis vidua,* and *Potamocypris smaragdina.* These species are commonly of varying shades of cream or light green, with blotches of dark green, brown, or black. Since these species are usually found swimming in aquatic vegetation, alga, and grass growing in the water, it is reasonable to suppose that the coloration affords them some protection from predatory animals. On the other hand,

other species of ostracods, especially species of Candona and Ilyocypris, are usually light in color, white to yellow, and are unmarked with stripes or blotches of deeper color. It may be that species such as these which live in temporary waters or creep over the bottom or through the mud in running waters are not subject to the same dangers as are species of ostracods which swim freely in the vegetation and so are apt to be eaten by plankton-consuming fishes.

Seasonal Distribution

Many of the ostracods of Illinois are seasonal in their occurrence. This is especially true of certain species which appear during the prevernal and die out in the aestival season. Other species are not found until the vernal or even the aestival season. The seasonal distribution of species collected by the writer is shown in Table 4. Since the writer has very few collections in the autumnal and none in the haemal seasons, the months from September to February inclusive are not shown in the table. Little is known of the American ostracods found during the winter months. From the fact, however, that many species are found in the prevernal season only as larvae, it is apparent that the number of species passing the winter in the adult stage is limited.

Since the seasonal distribution of the writer's collections was limited, the records of Sharpe (1897, 1908) have been taken into consideration, as indicated in the explanation to the table. By the amount of additional information given for several species by Sharpe's records, it is evident that the data on seasonal distribution are far from complete. A certain amount of valuable information, however, can be obtained from a study of the table. In the first place, it is evident that certain species are found typically in the vernal and early aestival seasons. These species include many of the Candona, especially those which are characteristic of temporary waters as *Candona fluviatilis, C. distincta, C. indigena, C. suburbana,* and *C. fossulensis.* Other Candona species are either scattered (as *C. albicans, C. biangulata,* and *C. punctata*) in such a way as to make the record insignificant or they are to be found during most of the year, as is *C. simpsoni* (Kofoid 1908). Of the Cypria species, *Cypria turneri* and *C. ophthalmica* are apparently found during the entire period from March to August inclusive. *C. maculata* shows the same distribution. *C. obesa* is evidently typical of the aestival season and later. Besides many of the species of Candona, *Cypricercus tuberculatus* and *C. reticulatus* appear to be forms which die out before the first of July. In addition to the Cypria species mentioned above, *Physocypria pustulosa* and *Cypridopsis vidua* are found throughout most of the entire period investigated. *Potamocypris smaragdina* apparently reaches its highest abundance in the

TABLE 4

Seasonal distribution as shown by the months in which each species was found. Since few collections were made in the months from September to February inclusive, these have not been shown. The name of each species is followed by the number of collections in which it occurred. The relative abundance of various species in the different months is indicated as follows: x—rare; xx—common; xxx—abundant. For the advantage of additional information, the records of Sharpe (1897, 1908) are indicated by the letter "y."

Species	Collections	Mar.	Apr.	May	June	July	Aug.
Candona simpsoni	85	xx	xxy	xxxy	xxx	xx	x
Candona punctata	2	x	..	..	x	..	..
Candona fluviatilis	3	..	..	x	x	..	..
Candona albicans	4	..	x	..	..	xx	..
Candona biangulata	5	..	x	xy	x	..	x
Candona crogmaniana	2	..	x	..	..	..	..
Candona sigmoides	4	..	..	y	x	..	x
Candona caudata	4	..	x	x	..	..	..
Candona distincta	3	..	x	x	..	..	..
Candona indigena	4	..	x	x	..	..	..
Candona suburbana	2	..	..	x	x	..	..
Candona acuta	6	..	..	xx	..	x	..
Candona fossulensis	2	..	x	..	..	..	..
Cyclocypris forbesi	1	..	y	..	..	..	x
Cypria turneri	30	xy	y	xxy	xxy	xy	xy
Cypria mediana	3	..	..	..	x	..	..
Cypria obesa	9	..	..	..	x	x	y
Cypria maculata	43	y	y	xy	xxy	xy	xy
Cypria ophthalmica	9	xy	y	xy	xy	y	xy
Physocypria pustulosa	175	..	x	xy	xxx	xxy	xxy
Ilyocypris gibba	44	..	..	xx	xxx	x	x
Ilyocypris bradyi	72	..	..	xxx	xxx	xx	x
Cypricercus tuberculatus	3	..	y	y	x	..	..
Cypricercus reticulatus	32	x	xy	xx	x	..	..
Cyprinotus incongruens	16	..	..	x	x	x	..
Notodromas monacha	1	..	y	y	xy	y(?)	..
Cypridopsis vidua	505	xy	xy	xy	xxxy	xxxy	xxxy
Potamocypris smaragdina	118	..	..	x	xxx	xx	xxxy
Darwinula stevensoni	1	..	..	..	..	..	x
Limnocythere reticulata	70	..	y	xx	xxx	x	x
Limnocythere verrucosa	4	..	..	..	..	..	x

aestival season. The status of the two Ilyocypris species cannot be determined from the field data, since few collections were made by the writer from streams during March and April, and the flooded condition of streams at this time makes results untrustworthy. That the absence of these two species from the vernal collections is more apparent than real may be suggested by Sharpe's record (1908) of these two species from Colorado in March. Alm (1916) states that *I. gibba* and *I bradyi* are found throughout the year, there being two generations. However, this does not necessarily mean that there are two generations each year in Illinois, especially since Alm states that the species in Sweden do not favor temporary waters. In Illinois, approximately one-half of the collections of these two Ilyocypris species were from temporary streams.

Reproduction and Ontogeny

No work has ever been done on the life histories and reproduction of American species except by Turner (1895) who made a study of the late larval stages of *Cypris herricki* Turner 1892, which is a synonym of *Chlamydotheca speciosa* Dana 1852 according to Furtos (1933). European writers have, on the other hand, published much on the development, reproduction, and life history of various species. Some of these studies are founded upon data secured from animals reared and observed in the laboratory (as Claus 1872); others such as the work of Alm (1916) are based largely on field collections. The writer believes either method alone to be relatively deficient and that the acceptable manner of investigation would be a preliminary study by either field or laboratory methods checked by the other method.

In general, the ontogenetic development of fresh-water ostracods is similar in different species, especially among the Cypridae. During development, nine instars occur, the last being the sexually mature animal. Claus (1872) worked out all the stages in the development of two European species: *Cypris ovum* (= *Cyclocypris ovum* (Jurine 1820)) and *Cypris fasciata* (= *Dolerocypris fasciata* (O. F. Müller 1776)). Claus found that the egg hatches into a shelled nauplius with three pairs of appendages, two representing the antennules and antennae, the third the mandibles. In general, a pair of appendages is added at each molt, with the furca appearing as two bristles in the fourth instar. Schreiber (1922) made a study of the larval stages of *Cyprinotus incongruens*. His results are slightly different from those of Claus. A comparison of the time of appearance of the appendages in the three species mentioned follows:

	Pairs of Appendages	
Instar	*Cypris ovum; C. fasciata*	*Cyprinotus incongruens*
1 (nauplius)	3	3
2	5	4
3	5	5
4	6	5
5	6	6
6	7	7

If a single pair of appendages were added in each stage as probably occurred in the ancestors of the group, it is evident that the sixth stage would have eight rather than seven pairs of appendages. Many writers account for this irregularity by assuming that the second maxillae which are present in many crustacea have been lost in the ostracods.

Not only is there an increase in the number of appendages at many of the earlier molts, but differentiation of the appendages occurs up to the late stages. Claus (1872) found that the antennule, for instance, of the

nauplius has four podomeres, another is added in the fourth instar, one more in the sixth, and still another in the seventh. The antenna of the nauplius has two podomeres, in the sexually mature animal (ninth stage) four, and in all other stages three. The legs and furca also begin as undifferentiated structures and pass through several instars before the adult condition is reached. The second leg, for example, has one podomere when it first appears in the second stage. Three podomeres are added in the sixth instar; in the seventh stage there is an additional podomere. The anlagen of the gonads are conspicuous in the seventh instar; the copulatory organs are present in the eighth instar; and the animal reaches sexual maturity in the final stage. The development in the Cytheridae is grossly similar to that of the Cypridae (see Klie 1926a).

Not only do the appendages increase in number and change in form, but the shell becomes altered in shape in various instars. This has often led to a description of the young as a new species (see "remarks" under *Cypricercus reticulatus*). In many species, the sculpturing of the young shell differs from that of the adult, and there are differences in coloring as well. An extreme difference between young and old shells is shown in *Cypris labiata* Sars 1901 (= *Chlamydotheca incisa* (Claus 1892)) in which Sars (1901) has shown that the young shell lacks the hyaline lip-like expansion of the anterior margin as found in the adult. The young, moreover, has a row of small denticles along the posterior margin of each valve not found in the adult. Turner (1895) found much the same condition in his *Cypris herricki* already mentioned. A series of drawings by Alm (1916:pl.I) shows the shell changes in several species common in Sweden. As far as the writer knows, no work has been carried out on the early stages of even the common species in North America.

In order to complete the references regarding development, mention should be made of the work of Müller-Calé (1913) in which the early embryology through the germ layers is considered. Reference may also be given to investigations on the development of eggs and sperm, chiefly that of Woltereck (1898), Schleip (1909), and Schmalz (1912).

The manner of reproduction in ostracods varies considerably in different species. Roughly speaking, the ostracods may be divided into four groups as far as type of reproduction is concerned:

1. Males unknown; reproduction apparently always parthenogenetic:

Candona fluviatilis	*Cypricercus fuscatus*
Candona simpsoni	*Cyprinotus pellucidus*
Candona biangulata	*Cypridopsis vidua**
Candona caudata	

*Sharpe in 1918 considers *C. vidua* as being temporarily parthenogenetic. The present writer has seen no males, and only one record (Spandl 1925) of the occurrence of males is known. This report is questionable and has been called "unglaubhaft" (unbelievable) by Klie (1938a).

2. Males found in a few localities, usually absent; reproduction ordinarily parthenogenetic:

Candona albicans
Ilyocypris gibba
Ilyocypris bradyi
Cyprinotus incongruens
Darwinula stevensoni

3. Males found in small numbers; reproduction supposed to be both syngamic and parthenogenetic:

Cypricercus reticulatus
Potamocypris smaragdina

4. Males always present; reproduction thought to be syngamic:

Candona punctata
Candona distincta
Candona crogmaniana
Candona sigmoides
Candona recticauda
Candona sharpei (?)
Candona indigena
Candona suburbana
Candona fossulensis
Candona acuta
Cyclocypris forbesi
Cyclocypris sharpei
Cypria turneri
Cypria mediana
Cypria obesa
Cypria maculata
Cypria ophthalmica
Physocypria pustulosa
Physocypria dentifera
Cypricercus tuberculatus
Notodromas monacha
Cyprois marginata
Limnocythere reticulata
Limnocythere illinoisensis
Limnocythere verrucosa

For details of the occurrence of males in groups two and three above, the reader is referred to the separate species descriptions given herein.

It will be noticed by reference to the last group above that a majority of Illinois species are syngamic. This group includes all the members of the family Cytheridae and many of the Cypridae. It is peculiar that many subfamilies of the Cypridae fall into more than one group as far as manner of reproduction is concerned. This variation precludes the possibility of using the manner of reproduction as a generic or specific criterion, since it is not related closely to the morphological structures used in classification.

That the method of reproduction varies in different localities is shown by Klie (1926a) regarding *Cyprinotus incongruens*. Males of this species have been found rarely in Germany and occur more frequently in Hungary and Bohemia. In North Africa, however, the males are as abundant as the females.

A definite alternation of periods of syngamic and parthenogenetic reproduction has not been shown in the ostracods. Wohlgemuth (1914) found a change from one type to another in populations under investigation in nature and in the laboratory. Whether or not an alternation similar to that in many Cladocera occurs or not is uncertain.

All the ostracods in Illinois are oviparous except *Darwinula stevensoni* which retains the eggs during development in the posterior dorsal part of the shell cavity. The eggs of oviparous species are usually attached to some substratum, especially plants, where they may undergo development at once or may remain, as in temporary ponds, for several months

surviving a period when the pond is entirely dry. The eggs are also able to withstand freezing. Because of the ability to withstand desiccation, Sars (1895, 1896, 1901) often imported mud to Norway from South America, Africa, and Australia. This mud was placed in aquaria and the ostracods allowed to develop. In this way, Sars received material not otherwise available.

The number of generations per year varies from one to many in different species. The best available example of a local species with a single generation each year is *Cypricercus reticulatus* which is chiefly an inhabitant of temporary ponds. The eggs hatch sometime during the month of March at the latitude of Central Illinois. The larval stages may be recognized by the characteristic shell reticulations which are absent in the adult. The larvae develop rapidly, and early in May the individuals become sexually mature, lay their eggs, and die. No immature individuals are ever found after the first week in May. Several other ostracod species, chiefly those living in temporary ponds, also have one generation per year. Many of these are species of Candona which, as a result, have a limited seasonal distribution.

On the other hand, many species have a larger number of generations. Alm (1916) often assigns a particular number of generations to a certain species, but the writer feels that his results should not be carried over without verification to the same species in North America, since there is apparently much variation under different environmental conditions. How many generations occur each year or the length of life-span are uninvestigated for American species. The present writer has observed that in *Cypridopsis vidua, Potamocypris smaragdina,* and probably some of the species of the subfamily Cyclocyprinae young are found nearly continuously during the summer. This would probably place these species among those with numerous generations each year.

Food

Food and feeding in the ostracods have been given little attention by investigators. The food of few species has been studied in detail, although a study of the food habits might have some bearing on problems of distribution. In Europe, a very detailed study of the mouth parts and method of feeding in a single species has been carried out on *Notodromas monacha* by Storch (1926, 1933). Most species feed on bacteria and other minute organisms as well as detritus. Klugh (1927) in feeding experiments on *Cyprinotus incongruens, Cypridopsis vidua,* and *Cypria exculpta* (? = *C. turneri sp. nov.*) found that the animals ingested both algae and detritus, but in most instances thrived better when fed the former. Since the mouth parts are setaceous, they are well adapted for straining minute

organic particles from the water and forcing them into the mouth. At the same time, the mouth parts, especially the mandible, are capable of rasping material from solid bodies too large to be ingested. Many species, as some of the Candona species, apparently ingest large numbers of diatoms which they seem able to digest, since the cytoplasm within the test of the diatom stains when the plant is first ingested but only the empty test may be observed in the food balls in the posterior part of the intestine. In contrast to the smaller swimming species as *Cypria spp., Cypridopsis vidua,* and *Potamocypris smaragdina,* which feed on minute organic particles which they strain from the water, Klie (1926a) states that the larger species of Cyprinae often collect in masses to feed on the bodies of dead animals. It is probable that many of the creeping forms as *Candona spp.* and *Ilyocypris spp.* feed largely on organic materials and minute organisms in the bottom mud over which they creep.

GEOGRAPHICAL DISTRIBUTION OF OSTRACODS

World Distribution of Species Found in Illinois.—The knowledge of the geographical distribution of ostracods is far from complete as a result of the lack of information relative to the faunas of many localities. In general, however, most genera and many species of ostracods are nearly cosmopolitan in their distribution. Only two well differentiated freshwater genera are known to be confined to the Western Hemisphere. The genus Chlamydotheca* was said by Brehm (1939) to be the only genus restricted to the Americas. This genus is represented by an abundance of species in South and Central America and the southern part of North America. The genus Entocythere, species of which live in the gill cavities of crayfish, is known only from North America and was apparently overlooked by Brehm. Another genus, Candocypria Furtos 1933, is known only from the United States but, since it represents a transition between two well known genera (Furtos 1933), it seems inadvisable to consider it as a well defined genus as far as geographical distribution is concerned.

All the genera and many of the species of free-living ostracods found in Illinois are Holarctic in their distribution. This results in a close resemblance between European and North American ostracod faunas. While many of the species are Holarctic in their range, the species of the genera Candona and Limnocythere are often much restricted, even though the genera themselves are widespread. In the case of the Candoninae, this localized condition may possibly be the result of a rapid

*Reports of species of Chlamydotheca from outside the Americas are based on erroneous generic determination (Klie 1930; Brehm 1932).

evolution of species occurring at the present time, as is suggested by the great specific variability and the large number of closely related species in the group. The following list indicates the geographical distribution of Illinois ostracods as determined from the literature.

1. Cosmopolitan except Australia:
   Cyprinotus incongruens
2. Holarctic and South America:
   Cypridopsis vidua
   Cypria ophthalmica
3. Holarctic:
   Ilyocypris gibba
   Ilyocypris bradyi
   Cypricercus fuscatus
   Cypricercus reticulatus
   Notodromas monacha
4. Europe and North America:
   Candona albicans
   Candona caudata
   Potamocypris smaragdina
   Cyprois marginata
   Darwinula stevensoni
5. North America:
   Cypria turneri
   Cypria maculata (?)
   Cyprinotus pellucidus
   Physocypria pustulosa
6. United States:
   Cyclocypris forbesi
   Cyclocypris sharpei
   Physocypria dentifera
7. Central United States:
   Candona punctata
   Candona simpsoni
   Candona distincta
   Candona crogmaniana
   Candona indigena
   Cypria obesa
   Cypricercus tuberculatus
8. Illinois only:
   Candona fluviatilis
   Candona biangulata
   Candona recticauda
   Candona sharpei
   Candona sigmoides
   Candona suburbana
   Candona fossulensis
   Candona acuta
   Cypria mediana
   *Limnocythere reticulata**
   Limnocythere illinoisensis
   Limnocythere verrucosa

Distribution of Ostracods in Illinois.—In general, the ostracods reported from Illinois may be divided into two groups: (1) those having a more or less general distribution throughout the state and (2) those limited in their distribution to restricted areas in the state. Most of the species belong to the first group. Of the species in the second group, the writer found that certain species occur only in collections from Champaign County and bordering counties, others are found only in the lakes of northeastern Illinois, and still others are confined to the southern portion of the state where the waters are often acid. The localized occurrence of certain species in Champaign County is not particularly significant

*As explained in "remarks" under the description of this species, the record of *L. reticulata* for Maine appears to be erroneous as a specific determination. Therefore, *L. reticulata* is included with the species limited to Illinois rather than with those from the United States.

since the writer made an intensive study of the vernal ponds in the region and, as a result, found species which probably escaped collection in other parts of the state. Of considerable significance, however, is the restriction of certain species to the Chicago region and to the southern portion of the state. Among the ostracod species apparently found only in the Chicago region may be listed *Cypricercus tuberculatus, Notodromas monacha, Cyprois marginata, Darwinula stevensoni,* and *Limnocythere verrucosa.* Three of these, *Cypricercus tuberculatus, Darwinula stevensoni,* and *Limnocythere verrucosa* are found only in the lakes of glacial origin northwest of Chicago. Two species, *Candona punctata* and *Cypria mediana,* appear to be confined to the southern part of the state.

MORPHOLOGY OF FRESH-WATER OSTRACODS

For a complete understanding of the relationships among groups and species of the Ostracoda and in the use of the diagnostic keys, a working knowledge of morphology is necessary. The descriptive morphology as given here is offered not as a complete treatise on the subject but as an aid in systematic work.

Shell

The body of the fresh-water ostracod is completely enclosed by a bivalve shell (fig. 96) from which no part of the body extends when the shell is entirely closed. When the animal is active, however, the appendages used in swimming and creeping extend ventrally and anteriorly from between the laterally placed valves (fig. 1). These valves are duplicatures of the skin folds continuous dorsally with the body of the animal. Each skin fold secretes shell material from both its surfaces, and the outer and inner plates thus formed are fused together along the anterior, posterior, and ventral margins of the shell. The outer plate is often more or less calcified throughout its extent, but the calcified area of the inner plate is limited to the marginal portion of the valve. The valves are often unequal (figs. 96, 121), as either valve may overlap the other along certain portions of the margin when the shell is closed. The nature of the overlap is usually a useful specific characteristic. Anterior, ventral, posterior, and dorsal margins are recognized. In some species of ostracods, the margin of the valve along a part or all of its length may display tubercles (figs. 116, 128), crenulations, or other structural markings. Often a hyaline border extends beyond the margin and may form an extensive lip (fig. 118). Pore-canals (fig. 128-P) occur in many species as minute canals lying between a submarginal line and the margin. When the submarginal line and the margin are far separated, the pore-canals are long and con-

spicuous; when, however, the margin is approximate to the submarginal line, the pore-canals may become obliterated.

The shell halves are connected along the dorsal margin by an elastic band sometimes reinforced in the Cytheridae by a toothed, locking structure (fig. 137-AT, PT) which makes the closing of the valves more certain. The halves are unconnected along the anterior, posterior, ventral, and the fore- and hind-dorsal margins. The elastic hinge opens the shell much after the manner in which opening of the shell is carried out in bivalve molluscs. The closing of the shell is brought about by the contraction of a bundle of adductor muscles which extends from one valve to the other, passing transversely through the body of the animal. The area of attachment (figs. 40-M, 127-S) of the adductor muscles is conspicuous on the valves of the shell. These muscle scars are located anterior to the middle of each valve.

The nature of the surface of the valves often provides specific characters useful in diagnosis. Variations occur in both surface sculpturing and color. The shell surface may be smooth, pitted, or papillose. Setae are commonly present along the valve margins and to a varying degree on the shell surfaces. These setae may arise in connection with surface sculpturing (fig. 103) or may occur independently of such markings (fig. 118). In many instances, the color of the valve surface is so characteristic that the species may be determined by skillful examination of the color even in preserved material. In examining the shell for color, both reflected and transmitted light should be used in order to detect faint markings to the best advantage. In some instances, weak or faded markings are revealed only after the shell has been cleared in glycerine. Brown, green, or whitish gray are the prevailing colors. Color bands or blotches are usually of a darker shade of green, brown, or black. Some species exhibit a mother-of-pearl sheen when the valves are dried.

The size of the shell varies considerably in different species. The minimum length of the mature shell in any species is about 0.25 mm. while the maximum length of the shell is 21.0 mm. in a marine species of the genus Gigantocypris (G. W. Müller 1912). Fresh-water forms seldom exceed 3.0 mm. in shell length and in most cases are under 1.0 mm.

Body Segmentation and Appendages

The shortened body of an ostracod shows externally no trace of segmentation except as indicated by the metamerically arranged appendages (fig. 1). The boundary between the two body parts, the head and thorax, however, is marked by a slight constriction; the abdomen is wanting. The cephalic region bears four pairs of appendages: the antennules, the antennae, the mandibles, and the maxillae. The thoracic

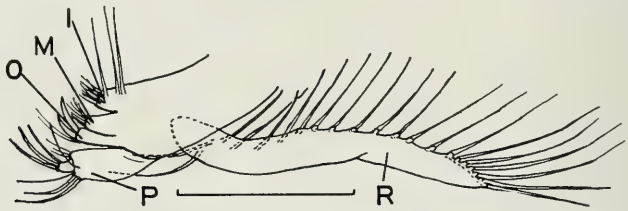
region has three pairs of appendages: the first, second, and third thoracic legs. The body ends in a pair of furcal rami (except in Darwinulidae) homologous to the post-abdomen of the Cladocera. In the fresh-water species, the appendages, including the antennae, are formed chiefly of the endopodite as a result of the loss or reduction of the exopodite.

The two or three eyes (fig. 1-E), which are separated in the primitive condition, are fused together to varying degrees. The eyes are usually located in the dorsal part of the head anterior to the shell hinge and are mounted on a low dorsal projection near the base of the antennules. The eyes appear as a dorsal colored fleck when the shell is gaped. When the shell is closed, the eyes may be seen as a pigment spot through the shell in species having translucent valve lamellae. The eyes and the upper and lower lips are not often mentioned in taxonomic work.

Anterior and dorsal to the mouth may be found the first cephalic appendages, the antennules (fig. 1-AU) (often referred to as the first antennae). The antennules are uniramous, the exopodite being lost. Typically each antennule is composed of eight podomeres but through fusion may approach a condition in which there are only five. The basal portion or protopodite consists regularly of two podomeres which some writers believe to be a single divided podomere (cf. Furtos 1933; Klie 1938a). In the Cypridae, the endopodite consists typically of five podomeres; in the fresh-water Cytheridae of North America it is reduced to three or four podomeres. The antennules usually carry short, stiff, claw-like bristles for digging and climbing (Darwinulidae and Cytheridae) or long, feathered setae for swimming (fig. 1-N) (majority of the Cypridae).

The second pair of cephalic appendages are the antennae (fig. 1-AN). These are termed the second antennae when the antennules are designated as the first antennae. Each antenna includes a protopodite of one or two podomeres and an endopodite of three or four podomeres. The exopodite is reduced to a scale usually bearing three setae in the Cypridae, to a long bent seta (fig. 131-F) containing the duct of a gland secreting adhesive material in the Cytheridae, or is entirely vestigial in the Darwinulidae. On the posterior margin of the first podomere of the endopodite in the Cypridae is found a sensory organ (figs. 8-S, 106-O). This same podomere often carries close to its distal end a group of five long setae (fig. 1-V) which, when well developed, are used in swimming by many of the Cypridae. These setae are greatly reduced in the Cytheridae and the Darwinulidae, and are wanting in the Candoninae of the Cypridae. Claws are found on the ultimate podomere of the endopodite. The antennae function in locomotion, in feeding, as a sensory structure, and in the male as an organ for holding the female during copulation.

The third pair of cephalic appendages are the mandibles located at the sides of the mouth. Each mandible (figs. 1-M, 43) consists of a base of two podomeres, a palp which represents the endopodite, and a branchial plate (fig. 43-R) (sometimes reduced to a few setae) which is modified from the exopodite. The basal portion is highly chitinized as it is to this portion that the muscles used in operation of the mandibles are attached. The distal end of the mandible is truncate and provided with strongly chitinized teeth (fig. 43-C). The palp (fig. 1-P) consists of the three podomeres of the endopodite and the second podomere of the base. It bears claws and setae.



TEXT-FIGURE.—Mesial view of the left maxilla of *Candona acuta sp. nov.* (female). I—inner masticatory process; M—middle masticatory process; O—outer masticatory process; P—palp; R—respiratory plate. Scale: 0.2 mm.

The fourth pair of cephalic appendages are the maxillae, as shown in the accompanying text-figure. These are the first maxillae of many of the older authors, since this pair of structures is homologous with the first maxillae of other crustaceans. The base of the maxilla has typically three narrow distal masticatory processes and a palp of two or three podomeres. The exopodite is well developed, forming a branchial plate. The shape and number of setae on the masticatory process closest to the palp are of considerable taxonomic importance. This process has been variously called *the* masticatory process, the third masticatory process, and the outer masticatory process. The last is preferred by the present writer. In some Cytheridae, the palp and processes may be reduced.

The mandibles and the maxillae are the feeding structures, but the first thoracic leg sometimes assumes a similar structure and function. The mandibles not only break food into small particles but the palp helps in sweeping food toward the mouth. The mandibles are supported in function by the maxillae whose processes push food toward the mouth, while the branchial or respiratory plate not only removes excess and inappropriate food but also by its vibration creates a current of water for use in respiration. In reference to the masticatory processes, both the English term and its German equivalent (Kauladen) are misnomers, as the processes do not chew the food but merely pass particles toward the

mouth. The second maxillae are wanting in the Ostracoda, but in the older literature the term is sometimes applied to the first thoracic legs.

The thoracic portion of the body bears three pairs of appendages (figs. 1-R, L, T) except in the males of the Cytheridae, which have a pair of sensory structures (fig. 135) considered by some writers to be a fourth pair of thoracic appendages. The nature of the legs is a useful criterion for division of the fresh-water Podocopa into families. In the Cytheridae the first, second, and third pairs of legs are similar in structure and are pediform; in the Darwinulidae, only the second and third pairs are similar; and in the Cypridae, all the legs differ in structure.

The first thoracic leg (fig. 1-R) is often highly modified, and in the Cypridae so resembles the maxilla that it is designated in the older literature as the second maxilla. The first leg has at times also been referred to as the maxillary foot or maxilliped because of its resemblance to a "chewing foot" or jaw. In the Cypridae, the basal podomere or protopodite ends in a masticatory process bearing setae (fig. 9). The endopodite is modified as a palp often of a single podomere and the exopodite forms a branchial plate which may be reduced to one or a few setae as in the Cypridopsinae and Candoninae (fig. 9-R). The palp in the male is often modified to form a prehensile claw (figs. 22, 71) of one or two podomeres for use during copulation. When the prehensile palp is formed of two podomeres, the proximal one is called the propodus (fig. 122-P); the distal one is termed the dactylus (fig. 122-D). The first leg in the Cytheridae is similar to the other two thoracic legs, since it consists of an anteriorly directed protopodite carrying a pediform endopodite of three or four podomeres. The exopodite or branchial plate is wanting. In the Darwinulidae, the structure of the first leg is midway between the condition found in the other two families, since the masticatory process as well as the branchial plate is well developed, as in many Cypridae, and the endopodite is a pediform structure of three podomeres similar to that of the Cytheridae.

The second thoracic legs (fig. 1-L) (first thoracic legs according to those authors who recognize the here-designated first thoracic legs as second maxillae or maxillipeds) are uniramous and consist of a protopodite and a backwardly directed pediform endopodite at the end of which is usually a more or less curved claw (fig. 26-C). The endopodite consists usually of three or four podomeres, but in some species it may appear to have an additional podomere through a division of the next to the last podomere. The exopodite is lacking.

The third thoracic legs (fig. 1-T) (designated as second thoracic legs by those authors who describe the first pair of legs as second maxillae or maxillipeds) usually consist of five podomeres. The third leg is similar

to the second in the Cytheridae and the Darwinulidae, but in the Cypridae it consists of a basal podomere and an endopodite typically of three podomeres (fig. 4), of which one may be divided (fig. 53-P). In the Cypridae, this leg is modified as a cleaning foot (German: "Putzfuss") by being bent dorsally and by being distally adapted for use in keeping the shell and body free of foreign material. The modification consists either of the presence of several unequal setae, usually three in number and often reflexed in position, or a complicated pincer apparatus or chela formed from the last two podomeres of the third leg (fig. 120) in the Cyprinae *s. str.*

A possible fourth pair of thoracic appendages may be found in the so-called "brush-like" organ (German: "bürstenförmige Organ") (fig. 135) in the males of the Cytheridae. This appendage carries a tuft of setae and is richly supplied with nerves. Its structure has led to the assumption that it is a sexual sensory organ.

At the posterior end of the body in the Cypridae and the Cytheridae there are paired appendages which are the remains of the abdomen. When at rest, these furcal rami are directed ventrally between the third legs. By being articulated with the body, they are capable of movement and assist in locomotion. Typically, each appendage (fig. 69) consists of a basal portion or ramus proximally articulated with the body and ending distally in two setae and two claws. Various modifications may occur in the Cypridae by the loss or reduction of one or more of the claws or setae. The extreme degree of reduction in the Cypridae occurs in the Cypridopsinae where each furcal ramus is reduced to a small base, a dorsal seta, and a whip-like terminal part often referred to as the "flagellum" (fig. 117). In the Cytheridae, the furcal rami are very much reduced (figs. 132, 138); in the Darwinulidae, they are entirely wanting and the thorax ends in a short cone-shaped process (fig. 126).

Respiratory, Circulatory, Excretory, Digestive, and Nervous Systems

Respiration in the fresh-water ostracods is accomplished by gaseous exchange through the entire surface of the body and especially through the membranous inner lamella of the shell. Bernecker (1909) found the inner shell lamella in *Cyprinotus incongruens* to be made up of seven large respiratory cells which form a respiratory epithelium overlying the valve cavity which constitutes a blood sinus. The renewal of water within the shell cavity is accomplished by the movements of the appendages. Thus the respiratory plates of some of the appendages not only provide additional respiratory surface but also bring oxygenated water into contact with other body surfaces.

Like the gills, the heart is also wanting in fresh-water ostracods, although some marine species have a pulsating sac (Klie 1926a). Whether or not there is any adaptation for circulating the body fluids in forms lacking a heart is not known.

The excretory system in several species of European ostracods is described in detail by Bergold (1910). There are three excretory organs: the glands of the antennules, the shell glands, and the maxillary glands. Each of the glands of the antennules is small and opens to the outside ventral to the base of each antennule. The shell glands lie in the anterior part of the shell between the lamellae, and their ducts lead to the outside in the region of the second antennae. The third pair of glands are the maxillary glands. Each of these consists of a coelomic sac and a urinary duct, and one lies in the body at the base of each maxilla. By muscular constriction, the excretion is forced from the sac into the looped canal or duct.

Both Claus (1895) and Bergold (1910) discuss in detail the digestive system. The alimentary canal consists of three parts: the esophagus or fore-gut, the mid-gut, and the hind-gut. The food material in the form of minute organic particles is collected together in the atrium bounded by the mouth parts. Here the particles are cemented together by secretions from glands in the upper lip and in the base of the mandible near the distal teeth. This food is passed down the esophagus into the anterior portion of the mid-gut where the cells lining the tract are secretory and also function in absorption of nutritive material. The largest digestive gland is the paired hepato-pancreas or so-called liver which lies between the shell lamellae and empties into the mid-gut. The straight and short end-gut leads from the mid-gut to the anus which is located behind the furca. Food balls may be seen in the mid-gut when the animal is examined by transmitted light.

Good accounts of the nervous system in certain species of Cypridae are given by Turner (1896) and Hanström (1924). The nervous system in the fresh-water Cytheridae seems to have received no attention. In general "the central nervous system consists of a supra-oesophageal ganglion which is united to a ventral chain by a pharyngeal collar" (Turner 1896). The supra-esophageal ganglion is made up of a large number of fused ganglia, probably as many as seven (Turner 1896). The anterior group of fused ganglia of the ventral chain is usually designated as the infra-esophageal ganglion (Klie 1926a) and is made up of at least three ganglia. The antennules and the antennae are innervated by the supra-esophageal ganglion which is also connected to the optic ganglion of the eye. The infra-esophageal ganglionic mass innervates the mouth parts and the closing muscle of the shell. Posterior to the infra-esophageal mass, there lie the two paired ganglia of the ventral chain. The first

innervates the first thoracic legs, the second gives off paired nerves to the second and third thoracic legs and an unpaired nerve to the sexual apparatus. While the ventral ganglia in the species examined by Turner (1896) are well separated, Hanström (1924) found the infra-esophageal ganglion and the visceral ganglia of the ventral chain to be fused closely together in certain European species of Cypridae.

The sensory organs include the eye, tactile receptors, and chemoreceptors. The eye usually consists of three optic systems more or less fused together and is placed dorsal to the base of the antennules. The eye is made up usually of three pigment cups, one median and two lateral (Nowikoff 1908). Nowikoff, in working chiefly on European species of the subfamily Cyprinae, found that each eye cup contains a number of eye cells forming a concave retina. The number of cells in each lateral cup is ten to fifteen, in the median one only seven or eight. The tactile organs are in the form of setae scattered over the shell and body. There are also well developed specialized tactile setae on many of the cephalic appendages.

One very important sensory organ (fig. 8-S) is the one on the antepenultimate podomere or first podomere of the endopodite of the antennae in the Cypridae. This has been considered an olfactory organ.

Reproductive System

The female sexual organs consist of paired ovaries, oviducts, seminal receptacles, and genital openings. In the Cypridae the ovaries lie in the space between the lamellae of each valve (figs. 18-O, 40-O) where in many species they may be seen by transmitted light. In the Cytheridae the ovaries lie lateral to the mid-gut in the body of the animal. Each oviduct is joined near the outer end by the duct from the seminal receptacle. The female genital openings lie between the third thoracic legs and the furcal rami and may be at the end of distinctly well developed paired genital lobes (figs. 30-G, 37-G) as in many of the Candoninae.

In the Cypridae, the testes lie in the cavity of the valves (figs. 21-T, 41-T), and each testis usually consists of four branches. The branches unite to form the vas deferens of each side as they leave the valve cavity dorsal to the muscle scars. The vas deferens makes several coils or loops and then enters the dorsally and posteriorly located ductus ejaculatorius or Zenker's organ (figs. 93, 123) which by alternate contraction and expansion forces the sperms into the penis during copulation. The paired copulatory organs are located posteriorly to the ejaculatory ducts and serve to carry the sperm to the female. Each copulatory organ or penis often has three lobes but some of these may be wanting (figs. 57, 72, 81).

Like the ovaries, the testes in the Cytheridae lie along the intestine in the body proper. In members of this family there is no ductus ejacu-

latorius. The copulatory organ consists of paired plates often with several appendages (figs. 134, 141).

TAXONOMY

ORDER OSTRACODA

The Ostracoda, for which the common name "mussel-shrimps" (German: "Muschelkrebse") has been suggested by Johansen (1921), include those crustacea which are enclosed by a dorsally hinged bivalve shell and which never have more than four pairs of postoral appendages. The ostracod shell bears some resemblance to the shells of certain Phyllopoda (Conchostraca) but may be readily distinguished from the phyllopod shell by the lack of growth lines. Furthermore, the Ostracoda may be easily and certainly separated from the shelled Phyllopoda by the specialized appendages of the former in contrast to the large number (at least twenty) of foliaceous postoral appendages in the latter. On superficial examination the shell of certain of the small bivalve molluscs (as the Sphaeriidae) may also be mistaken for an ostracod shell by one not familiar with the gross appearance of the forms. These may be readily differentiated from ostracods by the presence of growth lines on the shell and the lack of jointed appendages.

The order Ostracoda (with reference only to recent species) contains about fifteen hundred valid species and perhaps nearly a thousand additional species of uncertain status. Many ostracods are marine but there are approximately five hundred recognized species from fresh waters.

SUBORDERS OF THE ORDER OSTRACODA

The order Ostracoda may be divided into four suborders, based chiefly on the nature of the shell, the number of postoral appendages, and the character of the furca. The Ostracoda of fresh waters belong entirely to the suborder Podocopa *s. str.,* which also includes some marine species. The other three suborders are strictly marine.

The suborder Podocopa *s. str.* may be characterized as follows: Shell without a permanent aperture anteriorly. The antenna with the endopodite well developed, but the exopodite, at the most, represented by a single long seta (fig. 131-F) or small setae-bearing scale. Both antennules and antennae are used in locomotion, either in swimming or creeping. The mandibular palp consists of four podomeres (figs. 25, 43). The heart is wanting; eyes are usually present. Four pairs of postoral appendages are present. Caudal ramus, when well developed, rod-shaped (fig. 37-B); often reduced (figs. 117, 132). Inhabitants of fresh and marine waters. Over one-half of the known ostracods belong to this suborder.

For completeness and general information, some indication of the characteristics of the three strictly marine suborders and a comparison of their structure with the suborder Podocopa is given here:

(a) The suborder Myodocopa *s. str.* is characterized by having at the anterior end of the shell a permanent opening through which the antennae may be extended for use in locomotion when the shell is otherwise tightly closed. The antennules are not highly developed for swimming. There are four pairs of postoral appendages, and the furca is lamelliform. A heart is present. The suborder Podocopa *s. str.* may be separated from the suborder Myodocopa *s. str.* by a lack of a permanent anterior shell opening, the absence of a heart, and the presence of a bar-like rather than a lamelliform furca.

(b) The suborder Cladocopa may be separated from the suborder Podocopa *s. str.* by the presence in the former of only two pairs of postoral appendages and by having the body terminate in reflexed lamelliform processes bearing numerous spines. The heart and eyes are absent in the suborder Cladocopa.

(c) The suborder Platycopa is characterized by biramous antennae, both branches being well developed with broad flattened podomeres. There are three pairs of postoral appendages, none of them distinctly leg-like. The furcal ramus is leaf-like, widened distally, and the margin bears many spines. The eye and heart are wanting. The subfamily Podocopa *s. str.* may be separated from the Platycopa by the presence in the former of four pairs of postoral appendages, usually well developed eyes, poorly developed exopodite of the antenna, and the bar-like furcal ramus.

While Sars (1928) and Klie (1938a) follow the division of the order Ostracoda into four suborders as given herein, G. W. Müller (1912, 1927) follows a different scheme and divides the order Ostracoda into two suborders: Myodocopa and Podocopa. The first suborder embodies the Myodocopa *s. str.* and Cladocopa as used herein; and the second combines the Platycopa and the Podocopa *s. str.* as recognized by the present writer. The system in which the order Ostracoda is divided into two suborders rather than four is certainly not a natural classification and is therefore to be avoided. Skogsberg (1920) recognizes five suborders, the additional group being formed by a division of the Myodocopa. Since the Myodocopa are entirely marine, no discussion need be given here of Skogsberg's classification.

FAMILIES OF THE SUBORDER PODOCOPA *s. str.*

The suborder Podocopa *s. str.* includes four families, three of which are found in fresh waters. If the suborder Podocopa is considered in the broad sense (as by G. W. Müller, 1912, 1927), then a fifth family, the family Cytherellidae, must be added to include the single marine genus

Cytherella. Cytherella, however, has many characteristics which are above the rank of family criteria and so is properly placed by itself in the suborder Platycopa.

The four families recognized herein as belonging to the suborder Podocopa *s. str.* are the families Cypridae, Darwinulidae, Cytheridae, and Nesideidea.* Of these, the family Nesideidae is strictly marine, Darwinulidae is entirely fresh-water, Cytheridae is chiefly marine with a few fresh-water genera, and Cypridae is common in both marine and fresh water. The following tabulation shows the chief structural differences among the four families of the suborder Podocopa *s. str.*

Family	*Teeth of shell hinge*	*Exopodite of antenna*	*Thoracic legs*	*Furcal ramus*
Cypridae	None	Reduced to a small scale bearing setae	All different	Usually well developed
Darwinulidae	None	Greatly reduced	Second and third similar	Wanting
Cytheridae	Present or vestigial	Large seta forming a gland duct	All similar	Reduced
Nesideidae	None	Small scale bearing a few setae	All similar	Well developed

KEY TO FAMILIES OF THE SUBORDER PODOCOPA IN ILLINOIS

1a. Exopodite of the antenna in the form of a long hollow seta carrying the secretion from a gland near the base of the antenna (fig. 131-F); the thoracic legs similar.....Family CYTHERIDAE

b. Exopodite of the antenna not as in the family Cytheridae; the thoracic legs not all similar.....2

2a. Second and third thoracic legs similar in structure and direction; furca wanting.....Family DARWINULIDAE

b. Second and third thoracic legs differ in structure and the direction of extension (fig. 1-L, T); furca present but sometimes much reduced.....Family CYPRIDAE

FAMILY CYPRIDAE

Surface of the shell usually smooth; dorsal margin without interlocking teeth. Eyes developed to varying degrees; either separated or fused into a single median eye. The antennules with a basal portion of two or three podomeres and an endopodite of four or five podomeres, with swimming setae well developed. The antenna with a basal part of

*The family Nesideidae should perhaps be replaced by Bairdiidae since the two names appear to be synonyms, at least by virtue of their having synonymous type genera, Bairdia M'Coy 1844 being recognized as synonymous with Nesidea Costa 1847. The genus Bairdia and the family Bairdiidae have long been accepted by geologists in reference to fossils. The genus Nesidea and the family Nesideidae have, on the other hand, been used extensively by zoologists working on recent material. Sars (1928) approves the use of Bairdia rather than Nesidea for recent species and this practice should perhaps be followed.

two podomeres and an endopodite of three or four podomeres. The exopodite is reduced to a small scale-like appendage bearing at the most three setae. First thoracic leg not pediform but modified as a mouth part, with the anterior margin of the base adapted for feeding. The endopodite of the first leg forms a small palp in the female but is enlarged to form prehensile organs in the male (figs. 63, 122). The second thoracic leg has an endopodite of three or four podomeres and a strong distal claw (fig. 26). The third leg is bent dorsally and is probably used in cleaning the respiratory surfaces and other parts of the body. The third leg usually has three distal setae (fig. 27) but the distal end may be modified for grasping (fig. 120). The furca is typically well developed and rod-shaped (fig. 11) but may be reduced to a "flagellum" or whip-like structure (fig. 117) (Cypridopsinae). The gonads are located within the valves of the shell. In the male, a portion of the vas deferens is modified to form an ejaculatory duct (fig. 93). The family Cypridae is large and includes the majority of fresh-water ostracods.

Since the family Cypridae is so large, it has been convenient to subdivide it into several subfamilies. Two well recognized subfamilies, Pontocyprinae and Macrocyprinae, are strictly marine and merit no further consideration here. Fresh-water representatives of this family have been systematized into a varying number of subfamilies. G. W. Müller (1912, 1927) recognizes, in addition to the two marine subfamilies mentioned, only three subfamilies in the Cypridae; the subfamily Candoninae (Candocyprinae of some authors), the subfamily Ilyocyprinae, and the subfamily Cyprinae. Two of these subfamilies are conglomerations of genera with greatly diversified characterization and as a result the groupings are distinctly unnatural. In order to form natural groupings, as far as the subfamilies are concerned, it is necessary to split the Candoninae and the Cyprinae into smaller groups, each representing a single genus or a group of closely related genera. Kaufmann as early as 1900 (1900b) divided the family Cypridae into eight subfamilies. His system is usable with a few minor corrections in orthography and a combination of his subfamilies Herpetocypridinae and Cypridinae into the subfamily Cyprinae *s. str.* The fresh-water subfamilies of the family Cypridae may be listed as follows, with the two recognized schemes in parallel columns:

Subfamilies according to G. W. Müller (1912, 1927) and Klie (1938a)	*Subfamilies after Kaufmann (1900b); used by Wagler (1937) and the present writer*
Candoninae (Candocyprinae)	Candoninae *s. str.* Cyclocyprinae
Ilyocyprinae	Ilyocyprinae
Cyprinae	Cyprinae *s. str.* Cypridopsinae Notodrominae

All the subfamilies listed to the right are strictly fresh-water inhabitants except the subfamily Cyclocyprinae which has, in addition to several genera found in fresh water, a single genus which is marine.

KEY TO SUBFAMILIES OF THE FAMILY CYPRIDAE FOUND IN FRESH WATERS

1a. Furcal rami greatly reduced, whip-shaped, without a terminal claw at the end (difficult to observe) (fig. 117).....Subfamily Cypridopsinae
b. Furcal ramus well developed, bar-shaped, with two terminal or subterminal claws (fig. 11).....2
2a. Outer masticatory process of the maxilla with six nearly equal setae modified to form toothed spines (fig. 113).....Subfamily Notodrominae
b. Outer masticatory process with two or three of the setae modified as spines...3
3a. Swimming setae of the antenna completely wanting (fig. 8).....Subfamily Candoninae *s. str.*
b. Swimming setae of the antenna present (fig. 1-AN, V).....4
4a. Third thoracic leg distally modified as a seizing apparatus, the ultimate podomere being beak-like with two well developed bristle-like setae, the third seta wanting or hook-like (fig. 120).....Subfamily Cyprinae *s. str.*
b. Third thoracic leg not bearing a chela, last podomere cylindrical and bearing three setae (figs. 53, 75).....5
5a. Shell elliptical to subrectangular (fig. 99), swimming setae of the antenna do not extend much beyond the tips of the end claws; palp (endopodite) of the first thoracic leg small, pediform, of two or three podomeres.....Subfamily Ilyocyprinae
b. Shell usually short and rounded (fig. 73), at least not subrectangular; swimming setae of the antenna extend well beyond the terminal claws (in Illinois species); the palp of the first thoracic leg of one or two podomeres in the female, always two in the male; not pediform..Subfamily Cyclocyprinae

SUBFAMILY CANDONINAE *s. str.*

Shell white, porcelain-like, often with mother-of-pearl sheen when dry. Swimming setae of the antennae absent (fig. 8). Two special sensory setae are usually located at the juncture of the fourth and fifth podomeres of the male antenna. Respiratory plate (exopodite) of the first thoracic leg with two or three setae (fig. 9-R); palp (endopodite) in male and female unjointed. Third thoracic leg with three unequally long setae on the last podomere (fig. 4), the penultimate (third) podomere either divided (fig. 53-P) or undivided (fig. 10-P). If divided, the third leg has five apparent podomeres. Ejaculatory apparatus of the male usually with seven wreaths of chitinous spines; openings of the ejaculatory duct funnel-shaped.

The Candoninae are creeping and burrowing forms as indicated by the lack of swimming setae on the antennae. The members of this group

are found in a variety of habitats and are widely distributed. Many species, however, are taken sparsely because they are often limited seasonally and do not occur in great abundance.

The subfamily Candoninae contains, according to some authors, as many as five genera. Of these five genera, two, Candona and Paracandona, are found in North America. The genus Candona alone has been found in Illinois. Almost without exception, the Candoninae are restricted to the Holarctic Region.

Genus CANDONA Baird 1845

Valves of the shell white, sometimes transparent; may have a mother-of-pearl sheen; surface smooth, sometimes with scattered puncta and hairs; hairy in some species. Shell variable in shape and size, elongated ovoid to reniform (fig. 50), sometimes with a straightened dorsal margin and truncated ends (fig. 65). Swimming setae of the antennae absent (fig. 8); the antennae of five podomeres in the female, often of six apparent podomeres in the male through a division of the penultimate; two male setae often present at the juncture of the two divisions. The last two podomeres of the mandibular palp short, rounded (fig. 43). Respiratory plate of the first thoracic leg rudimentary, usually with two unequal setae, never more than three (fig. 9-R). The third thoracic leg commonly of four podomeres; sometimes appearing to consist of five podomeres through a division of the third or penultimate podomere (fig. 53-P). When such a division occurs, there is no seta at the juncture of the two divisions. The terminal podomere of the third thoracic leg is short and bears two backwardly directed setae (fig. 4-C) and one long forwardly directed seta. The furcal ramus (fig. 11) is strong, bearing two strong claws and one or two setae; the dorsal seta often being removed from the subterminal claw by about twice the least width of the ramus. Male sexual organs with the characteristics of the subfamily.

Fifteen species of the genus Candona have been found in Illinois. Of these, six are described herein as new species. Of the six species of Candona reported for Illinois by Sharpe (1897), the present writer has rediscovered and added to the description of two, has redescribed one as a new species on the basis of additional material which showed that it is not the European species to which it was assigned by Sharpe, and has found one to be a synonym. Two of Sharpe's reported species were not found in the present writer's collections. One of these two, however, was assigned a new name because the individuals as described obviously do not belong to the species to which they were assigned by Sharpe.

The genus Candona is a very large one, over one hundred and fifty

species being reported in the literature. A lack of understanding of the relationships among species has resulted in the genus as a group becoming taxonomically unwieldy. Following a failure to divide the genus Candona by placing some of the species in new genera, various attempts have been made to divide the genus into groups. The groups suggested are of less than sub-generic value and each group is based on a type species. As early as 1900, G. W. Müller divided the genus as found in Germany into three groups. A discussion of this and later groupings may be found in Furtos (1933). The present writer has followed the system given by Klie (1938a) who has greatly modified the earlier scheme. According to Klie, there are seven groups in the genus Candona: groups Candida, Rostrata, Fabaeformis, Compressa, Acuminata, Cryptocandona, and Mixta. A key to these groups based on the work of Klie is given herewith.

KEY TO GROUPS OF THE GENUS CANDONA

1a. The branchial plate of the first thoracic appendage has two setae (fig. 9-R)...2
b. The branchial plate has three setae.....6
2a. The medial seta on the distal margin of the next to the last podomere of the mandibular palp feathered.....Group Candida
b. The above-mentioned seta unfeathered.....3
3a. Sexual lobe of the female mostly rounded (fig. 11-G); when pointed, then short and not prolonged lappet-like toward the posterior (fig. 15-G). Shell rounded; typically but not necessarily, the height is greater than one-half the length (fig. 2).....4
b. Sexual lobe of the female pointed and prolonged lappet-like toward the posterior (fig. 69-G). Shell typically elongated, height usually but not always less than one-half the length (fig. 58).....5
4a. Three setae in the bundle on the inner margin of the antepenultimate podomere of the mandibular palp.....Group Rostrata
b. More than three setae in the bundle (fig. 25-B).....Group Compressa
5a. Either three or five setae in the bundle on the inner margin of the antepenultimate podomere of the mandibular palp.....Group Fabaeformis
b. Four setae in the bundle (fig. 43-S).....Group Acuminata
6a. A seta is present in the middle of the penultimate podomere of the third thoracic leg.....Group Cryptocandona
b. The mentioned seta lacking.....Group Mixta

All seven groups of the Candona may be found in North America with the exception of the groups Cryptocandona and Mixta. It is impossible, because specific descriptions are incomplete, to assign some of the American forms definitely to the proper group. Moreover, there is some confusion in regard to many American forms because, as the groups are built around European type-species, American species do not always fit perfectly into this apparently artificial scheme.

The possible group assignments of species occurring in Illinois are as follows:

Group Rostrata
- *C. simpsoni* Sharpe 1897
- *C. punctata* Furtos 1933
- *C. fluviatilis sp. nov.*

Group Compressa
- *C. albicans* Brady 1864
- *C. biangulata sp. nov.*

Group Fabaeformis
- *C. sharpei sp. nov.* (very questionable assignment)

Group Acuminata
- *C. crogmaniana* Turner 1894
- *C. sigmoides* Sharpe 1897
- *C. recticauda* Sharpe 1897 (probable assignment)
- *C. sharpei sp. nov.* (questionable assignment)
- *C. caudata* Kaufmann 1900
- *C. distincta* Furtos 1933
- *C. indigena sp. nov.*
- *C. suburbana sp. nov.*
- *C. acuta sp. nov.*
- *C. fossulensis sp. nov.*

KEY TO SPECIES OF THE GENUS CANDONA IN ILLINOIS

(*Based on characters available in the female*)

1a. Penultimate podomere of the third thoracic leg undivided (fig. 10-P).....2
b. Penultimate podomere of the third thoracic leg divided (leg of five apparent podomeres) (fig. 53-P).....4
2a. Shell with high rounded arch dorsally; height more than one-half the length (fig. 2).....*C. punctata* Furtos 1933
b. Shell lacking a high rounded arch dorsally; height equal to or slightly less than one-half the length.....3
3a. Dorsal margin of the shell flattened and horizontal (fig. 6).....*C. fluviatilis sp. nov.*
b. Dorsal margin of shell forms a low evenly rounded arch (fig. 12).....*C. simpsoni* Sharpe 1897
4a. Shell of female less than 0.90 mm. in length.....5
b. Shell greater than 0.90 mm. in length.....6
5a. Shell with a conspicuous dorsal-anterior sinuation; anterior end narrowly rounded (fig. 24). Genital lobe of female conspicuous but small, cone-shaped (fig. 28-G).....*C. biangulata sp. nov.*
b. Shell without dorsal-anterior sinuation; anterior end broadly rounded (fig. 18). Genital lobe of female weakly developed, inconspicuous.....*C. albicans* Brady 1864
6a. Length of ventral margin of furcal ramus not over seven times the least width of the ramus.....*C. sharpei sp. nov.*
b. Ventral margin of ramus at least eight times the least width of the ramus....7
7a. Length of dorsal seta of furca more than four times the least width of the ramus and longer than the subterminal claw.....*C. crogmaniana* Turner 1894
b. Length of dorsal seta four times or less than four times the least width of the ramus and shorter than the subterminal claw.....8
8a. The terminal claw and more especially the subterminal claw of the furca weakly but distinctly S-shaped (fig. 37-C, T).....*C. sigmoides* Sharpe 1897
b. The terminal and subterminal claws gently curved, not S-shaped.....9

9a. In the third thoracic leg, the shortest seta has a length of over three times that of the ultimate podomere; the companion seta is about equal to or less than twice the length of the shortest distal seta (fig. 53) 10

b. In the third thoracic leg, the shortest distal seta has a length not over three times that of the ultimate podomere; the companion seta is over twice as long as the shorter of the pair (fig. 45) 14

10a. Shell rather elongate with the dorsal margin evenly arched; prominent posterior ventral angulation especially in the left valve (fig. 33) ..... *C. caudata* Kaufmann 1900

b. Shell with dorsal margin forming an angulation or sinuation or both (fig. 49) 11

11a. Shell height less than one-half the length. Female genital lobe a short cone (fig. 54-G) ..... *C. suburbana sp. nov.*

b. Shell height equal to or greater than one-half of the length. Female genital lobe well developed 12

12a. Tip of female genital lobe unevenly bifurcated (fig. 30-G). Posterior end of shell evenly rounded; prominent posterior-dorsal sinuation (fig. 29) ..... *C. distincta* Furtos 1933

b. Tip of genital lobe pointed. Posterior end of shell not evenly rounded, subtruncate; posterior-dorsal sinuation lacking or shallow 13

13a. Female genital lobe lappet-like and separated from the thorax (fig. 69-G). Shell without markings on the posterior slope; prominent posterior-ventral angulation (fig. 65) ..... *C. acuta sp. nov.*

b. Female genital lobe finger-like, not separated from the thorax (fig. 62). Sculpturing on posterior slope of female shell (fig. 59); juncture of posterior and ventral margin of shell rounded (fig. 58) .... *C. fossulensis sp. nov.*

14a. In the second thoracic leg, antepenultimate podomere at least equal to the penultimate (fig. 44). Companion seta of third thoracic leg equals two and one-half times the shorter of the pair (fig. 45) ..... *C. indigena sp. nov.*

b. The second thoracic leg with the antepenultimate podomere equal in length to two-thirds of the length of the penultimate podomere. Companion seta of the third leg has a length equal to three and one-half times the shorter of the pair ..... *C. recticauda* Sharpe 1897

Group Rostrata

Shell may be beset with many long hairs; shell often moderately short and high so that in most species the height exceeds one-half the length. The respiratory plate of the first thoracic leg is reduced to two setae (fig. 9-R). The mandibular palp has the medial seta on the distal margin of the penultimate podomere smooth, and the bundle on the antepenultimate podomere consists of three setae. Genital lobe of the female reduced and usually rounded (figs. 5-G, 11-G); if pointed, then short and not projected much posteriorly (fig. 15-G). Penis usually short and wide with the lobes flap-like and lying one over another. Three species of Candona, *C. simpsoni* Sharpe 1897, *C. punctata* Furtos 1933, and *C. fluviatilis sp. nov.* have been placed in this group.

KEY TO SPECIES OF THE GROUP ROSTRATA IN ILLINOIS

1a. Shell height considerably more than one-half the length; the length of the ventral margin of the furca over nine times the least width (fig. 5)..... .....*C. punctata* Furtos 1933

b. Shell height equal to or less than one-half the length; the length of the ventral margin of the furca less than nine times the least width (fig. 11)....2

2a. Dorsal margin of shell straight and horizontal (fig. 6); surface of shell sculptured (fig. 7).....*C. fluviatilis sp. nov.*

b. Dorsal margin of shell evenly arched (fig. 12). Shell elliptical; surface of shell smooth.....*C. simpsoni* Sharpe 1897

Candona punctata Furtos 1933

(Pl. I, fig. 2-5)

Candona punctata Furtos 1933. Furtos, 1933:485-486, pl. 13, figs. 2-8.

Type Locality: Ohio.

Description of the Female: A Candona of the Rostrata group. The shell (fig. 2) is much higher than one-half of the length; ventral margin nearly straight with but very slight sinuation; dorsal margin convex and passing into the posterior margin without an interruption in the arc. There is a shallow sinuation between the dorsal and the anterior margins. The anterior margin is more narrowly rounded than the posterior. A view from above was not obtained in the Illinois material but observations of single valves mounted in diaphane indicate a width of about four-fifths the height with sides centrally bulged and narrowed anteriorly and posteriorly, giving the animal, according to Furtos (1933), a spindle-form appearance. The left valve is slightly larger than the right. The valves have numerous long, heavy hairs which come from weakly developed papillae. The hairs are conspicuous along the anterior and posterior margins. The surfaces of the valves are areolated making accurate determination of the muscle scars hazardous. The muscle scars, however, appear to be five in number, arranged in a rosette, and are located subcentrally. The pore-canals are obliterated. A weak hyaline border is conspicuous beyond the margin proper. The dimensions of the valves of the single mature Illinois female are as follows (mounted in diaphane):

Right		Left	
Length	*Height*	*Length*	*Height*
0.80 mm.	0.45 mm.	0.83 mm.	0.46 mm.

According to Furtos (1933), the length of the female is 0.85 to 0.90 mm., the height 0.45 to 0.51 mm., and the width 0.37 to 0.42 mm. These measurements exceed slightly the size of the individual from Illinois.

The second podomere of the antennule bears a pair of setae, the longer of which reaches to the seventh or eighth podomere, the shorter only to the fifth or sixth podomere. The third and fourth podomeres of the

antennule are little longer than wide; the penultimate and ultimate podomeres are equal in length, the ultimate being about seven times as long as wide. The penultimate podomere of the antenna has on the inner edge a very short spine at the distal end of the basal one-third and a long seta at the beginning of the distal one-third. This seta reaches almost to the tip of the shortest distal claw of the appendage. The mandibular palp has the medial seta of the penultimate podomere unfeathered and three setae in the bundle on the antepenultimate podomere. The two longest claws of the ultimate podomere of the palp are nearly equal in length and shape. The branchial plate of the maxilla has sixteen rays.

The second thoracic leg (fig. 3) is composed of five podomeres, the second of which is equal to or slightly less in length than the sum of the third, fourth, and fifth podomeres taken together. The medial distal seta of the second podomere is equal in length to the width of the third podomere. The third or antepenultimate podomere is about twice as long as wide and has a seta about equal to or slightly larger than the width of the penultimate podomere. The penultimate podomere is not quite as long as the next proximally situated one but is of the same general shape. The ultimate podomere is much longer than wide. The terminal claw (fig. 3-E) is equal to one and one-third times the sum of the lengths of the three distal podomeres. The third thoracic leg (fig. 4) has the penultimate podomere (fig. 4-P) undivided. The basal podomere has three setae. Third podomere (penultimate) about equal in length to the second and bears a seta which is hardly half as long as the length of the podomere. The ultimate podomere is square; the length of the shortest distal seta is three times the length of the ultimate podomere. The length of the longer companion seta is two and one-quarter to two and one-half times the length of the shorter (fig. 4-C). The oppositely directed seta is about three and one-fourth times as long as the shorter seta of the pair.

The furca (fig. 5) has a nearly straight ventral margin; the dorsal margin is slightly concave. The length of the ventral margin is ten times the least width of the ramus; the terminal claw is two-thirds as long as the ventral margin. The dorsal seta (fig. 5-D) is nearly two and one-half times as long as the least width of the ramus, and is located a distance of nearly twice the least width of the ramus from the subterminal claw. The length of the terminal seta is less than the least width of the ramus. The claws are long, slender, and gently curved with some indication of being fine-toothed. The female lobe is undeveloped (fig. 5-G).

Description of the Male: The present writer has observed no males of this species. According to Furtos (1933), the males reach a length of 0.93 mm. and the shape of the shell is very similar to that of the female.

Remarks: Most of the above description has been taken from a single

Illinois specimen. The description agrees definitely with that given by Furtos. Through the present writer's description, it is evident that this species belongs to the Rostrata group. Because of the uncertainty of the taxonomic importance which may be attached to different structures, it is not advisable at the present time to point out relationships beween *C. punctata* and related European species.

Ecology: Furtos (1933) reports *C. punctata* to be "common in temporary and permanent ponds, marshes and lakes. March to May, and November." A single mature female was found by the present writer in a collection made from a swampy pool on March 26, 1939; an immature female was collected from a shady pool in an old stream bed on June 6, 1940.

Distribution: This species was originally reported from several localities in Ohio by Furtos (1933). The present writer found a single mature female in a collection of crustacea from Indian Creek Valley near Carbondale, Jackson Co., Illinois. This collection was made by Mr. F. R. Cagle of the Southern Illinois State Teachers' College and sent to Dr. Victor Sprague from whom the writer obtained the material. An immature individual was obtained in a collection from Hardin County, Illinois.

Candona fluviatilis sp. nov.
(Pl. I, figs. 6-9; pl. II, figs. 10-11)

Type Locality: Illinois.

Description of the Female: A Candona of the Rostrata group. The shell is somewhat compressed; the width is less than the height. The valves (fig. 6) of sexually mature females range in length from 0.68 mm. to 0.76 mm. and in height from 0.33 mm. to 0.38 mm., the length being approximate to twice the height. The dorsal margin of the shell is straight, nearly horizontal; the anterior end is evenly rounded, a sinuation occurring between the anterior and the dorsal margins. The posterior end is rather blunt with a flattened margin. The ventral margin is centrally somewhat concave. The ovary is slender; the muscle scars (fig. 7-M) are subcentrally located and consist of a rosette of five scars with a single slightly more dorsally located scar and often another scar anterior to the group. The submarginal line is so close to the valve margin that the pore-canals are practically obliterated anteriorly and posteriorly. The shell is conspicuously sculptured (fig. 7-S), being entirely covered by areolations formed of pits separated by raised areas. Many very fine, short hairs are found on the surface and margins of the shell.

The antennules present few specific characters; the third and fourth podomeres are as wide as long, the fourth appears fused to the fifth; the fifth, sixth, and seventh podomeres are stouter and shorter than in many

Candona; the distal podomere is three times as long as wide. The sensory organ (fig. 8-S) of the penultimate podomere of the antenna reaches to the distal margin of the podomere. The ultimate podomere is about one and one-half times as wide as long; the longest claws of the penultimate and ultimate podomeres are as long as the sum of the lengths of the distal three podomeres of the appendage. The teeth of the mandible are long and finger-like, few in number. The medial-distal seta of the penultimate podomere of the palp is smooth; there are three setae in the bundle on the antepenultimate podomere of the mandibular palp. The branchial plate of the maxilla has twenty-three rays, five of which are directed orally. Details of the first thoracic leg are shown in the figure (fig. 9). The second thoracic leg has the distal setae of the second, third, and fourth podomeres approximately equal to the distal width of the respective podomere. The ultimate podomere is longer than wide and bears, in addition to the long claw, two setae, the shorter of which is about as long as the width of the distal end of the podomere, the other approximately equal in length to the proximal margin of the podomere. The length of the terminal claw of the second leg is one and one-third times the sum of the lengths of the three distal podomeres.

The basal podomere of the third thoracic leg (fig. 10) has three setae; the penultimate podomere (fig. 10-P) is undivided. The ultimate podomere is at least as wide as long; the short seta measures two and one-half to three times the length of the podomere, the companion one is two and one-fourth to two and one-half times as long as the short seta, and the oppositely directed one is but little longer, if any, than the other long seta. The seta of the penultimate podomere is seven-eighths as long as the podomere. The furcal ramus (fig. 11) is rather stout and little curved, the length of the ventral margin is approximately six times the least width; the dorsal seta is subequal to twice the least width of the ramus and is located from the subterminal claw a distance equal to the least width of the ramus. The claws are slender, gently curved, and nearly equal in length; the terminal one has a length equal to six-sevenths of the ventral margin of the ramus. The teeth of the claws are so fine that superficially they appear smooth. The length of the terminal seta is approximately equal to one-half of the least width of the ramus. The female genital lobes (fig. 11-G) form large, well rounded semicircular flaps which extend posterior to the furcal rami when the furca is flexed. No seta is found on the thorax dorsad to the furca.

Male: The male is unknown.

Remarks: The combination of characters found in this species makes comparison with other species of the group Rostrata more or less worthless until more information is available regarding the details of anatomy of the American forms.

Ecology: *C. fluviatilis* has been taken in only three collections, all of which were from small vernal streams not over three feet wide and ten inches deep, with clear, gently flowing water usually over a muddy bottom.

Distribution: Several mature individuals of *C. fluviatilis sp. nov.* were taken on June 20, 1940, near Roberts, Ford County; a single individual was taken on May 18, 1940, near Savoy, Champaign County; and three very immature specimens were collected near Henry, Marshall County, Illinois on May 30, 1940.

Cotypes are deposited in the U. S. National Museum (Cat. No. 81066), in the collection of Dr. H. J. Van Cleave, and in the writer's collection.

Candona simpsoni Sharpe 1897

(Pl. II, figs. 12-17)

Candona simpsoni Sharpe 1897. Sharpe, 1897:452-454, pl. 46, figs. 1-6; Kofoid, 1908:258.

Candona reflexa Sharpe 1897. Sharpe, 1897:457, pl. 47, figs. 1-3; Kofoid, 1908:258.

Candona exilis Furtos 1933. Furtos, 1933:483, pl. 12, figs. 14-17.

Type Locality: (*C. simpsoni*) Illinois; (*C. reflexa*) Havana, Illinois; (*C. exilis*) Ohio.

Description of the Female: A Candona assignable to the Rostrata group. The shell (fig. 12) is, in general, elongate-elliptical, two and one-fourth times as long as high, well rounded anteriorly, rounded or a little pointed posteriorly. The dorsal margin is weakly arched; the ventral margin slightly sinuated. From above, the width is approximate to the height, the outline of the shell is subelliptical, and the anterior part is somewhat more pointed than the posterior. The valves are slightly beset with hairs, each hair being set on a rather prominent papilla. Although the shape and the actual size of the shell varies considerably, the length to height ratio seems to remain rather constant. Sharpe (1897) gives the size for *C. simpsoni* as follows: 0.73 mm. long, 0.30 mm. high, and 0.29 mm. wide. Furtos (1933) in describing *C. exilis* gives the length as 0.81 mm., height as 0.38 mm., and width as 0.37 mm. The dimensions given by Furtos are near the largest size found by the writer. Measurements of several valves from Illinois specimens are as follows (mounted in diaphane):

Right		Left	
Length	*Height*	*Length*	*Height*
0.78 mm.	0.36 mm.	0.80 mm.	0.— mm.
0.72	0.33	0.74	0.34
0.73	0.33	0.75	0.34

Sharpe (1897) mentions that the antennae of the female are "shorter and thicker than usual" and this holds true in most individuals but there

is a slight tendency for the antennae to become more elongate in individuals which have nearly straight, slender furcal claws. The medial seta of the penultimate podomere of the mandibular palp is smooth; three setae form the group on the antepenultimate podomere of the mandibular palp. The second thoracic leg consists of five podomeres, "terminal segment conical, approximately as long as the penultimate, which is about as wide as long; antepenultimate segment like the penultimate,—the three combined being but an eighth longer than the second segment. Terminal claw as long as the last three segments" (Sharpe, 1897). In many individuals, the three distal podomeres of the second thoracic leg are a little longer than wide; the entire leg is more slender than shown by Sharpe (1897:pl. 46, fig. 5).

The penultimate podomere of the third thoracic leg (fig. 13) is undivided. In the individuals which closely approach the original description of *C. simpsoni,* the penultimate podomere bears several minute spines scattered over the surface. These are not always conspicuous. The ultimate podomere is as wide as long. The shortest distal seta is about two and one-half times as long as the length of the ultimate podomere. Sharpe (1897:pl. 46, fig. 2) shows the shortest distal seta as being straight; Furtos (1933) states that the seta is sharply bent near the tip in *C. exilis.* Individuals which show either straight or bent setae are common; a few individuals have been observed in which the seta is recurved. Individuals may also be found with the "reflexa" type of strongly bent seta. In relation to the shortest distal seta, the companion seta is two to nearly three times as long and the oppositely directed seta is about three times as long.

The furca (figs. 14, 15, 16) is extremely variable especially in regard to the shape of the terminal and subterminal claws. In general, the length of the furca is between six and eight times the least width of the furcal ramus. The dorsal seta is always long, being usually twice the least width of the ramus, occasionally a little longer. It may be abruptly bent dorsally near the distal end and is removed from the subterminal claw an average of one-fourth the length of the dorsal margin of the furca. The length of the terminal seta is usually about one-half the least width of the ramus, but in a few individuals may be nearly as long as the least width of the ramus. The length of the terminal claw is from one-half to two-thirds the length of the furcal ramus. The terminal claw may vary from rather stout to slender and is more or less curved near the tip. Both subterminal and terminal claws are toothed, the teeth usually appearing very prominent in the center of the proximal one-half of each claw. An extreme amount of variation is shown in the subterminal claw. In the individuals described by Sharpe (1897:pl. 46, fig. 6), the subterminal claw is decidedly S-shaped (fig. 14). Furtos (1933:pl. 12, fig. 17) shows this struc-

ture in *C. exilis* as having at the most only a very slight tendency to be S-shaped (fig. 15). The writer has seen both of these shapes represented in his Illinois material with a perfect transition between the two. In addition, the writer has observed individuals in which the subterminal claw is very long and slender with the proximal portion straight and the distal portion only slightly curved (fig. 16). The female genital lobe (fig. 15-G) is poorly developed. It is represented by a small and slightly posteriorly extended thoracic process.

Male: The male is not mentioned by Sharpe (1897, 1918). Furtos (1933) states that the male is unknown. The present writer has seen no mature males assignable to *C. simpsoni.* However, a few uncertain immature males with entirely undeveloped copulatory organs have been noticed in collections containing mature females of *C. simpsoni.* These doubtful individuals were too incompletely developed to make certain any identification or to merit description at this time.

Remarks: Candona simpsoni is the most variable species of ostracod observed by the writer. It is only through a very large series of collections that such variation can be studied. A study of single, isolated individuals instead of a series might lead, in the instance of this species, to the description of three or possibly four species. Through observations made upon material from sixty different localities, it has been possible to determine the variation existing in this species and to demonstrate that the series representative of the species is definitely without any sufficient break to allow even the recognition of subspecies.

The most constant characters are size and shape of the shell. Beyond this, most of the structures usually considered to be of specific importance are very variable. The variability of the appendages lies chiefly in the relative length of the entire appendage and its parts. The writer applied statistical methods to a study of thirty individuals, representing all shapes of the subterminal furcal claw. Measurements were made of eight different structures of the second and third thoracic legs and the furca. From these data, ratios were figured between the following measurements: the length of the claw and the length of the ultimate podomere of the second leg, the length of the short seta and the length of the ultimate podomere of the third leg, the length of the dorsal seta and least width of the furcal ramus, and the length of the terminal claw and least width of the furcal ramus. In every instance except one, an unimodal curve resulted when frequency distributions of the ratios were plotted. The one exception was the frequency curve of the ratio of the dorsal seta of the furca and the least width of the ramus. This was a bimodal curve but there was no correlation whatever between the two peaks of the curve and the type of subterminal claw. From these data, the writer believes that he is justified in stating that the unimodal nature of the curves indicate conclusively the

presence of a single species among the diversified individuals measured. Moreover, the actual measurements of the various structures (length of ultimate podomere and length of the claw of the second leg; length of ultimate podomere and short seta of the third leg; and the least width, length of the dorsal seta, and length of the terminal claw of the furca), the distribution in Illinois, the type of habitat, and the dates upon which the collections were made show no correlation whatever with the shape of the subterminal claw of the furca.

Adequate transition individuals occur in which the animal displays characters of both *C. simpsoni* of Sharpe and *C. exilis* of Furtos. In many instances, the transition is self-sufficient to prove conclusively that both of these species are the same. In one individual, there was found an S-shaped subterminal claw on one side of the body and a claw of the "exilis" form on the other side. Again, in an individual in which were found straight furcal claws as shown in figure 16, the antennae were stout and there were small spines on the sides of the penultimate podomere of the third thoracic leg (fig. 13) as is characteristic of the form "simpsoni." This individual had the shell size and distinctly curved short distal seta of the third leg described for the "exilis" form. Thus in some individuals, combinations of characters may be found which definitely unite the variable individuals into a single species. It is as easy to find an individual with a curved short distal seta on the third thoracic leg in the "simpsoni" form as it is in the "exilis" form, or for that matter in the form with straight claws; the small spines on the penultimate podomere of the third leg may also be found in all three forms if sufficient numbers of individuals are examined. There seems to be no correlation between the curved distal seta and the small spines mentioned above, and indeed no correlation with either of these and the type of furcal claw. Transitions also occur between *C. simpsoni* and *C. reflexa.* In some of the transitions, there may be found a short bent seta on the third leg as Sharpe described for *C. reflexa* and a typical S-shaped subterminal claw as found in *C. simpsoni.*

Whether or not there exists races with all of the individuals showing one type of furcal claw is not now certain. Such a problem involving the examination of large numbers of individuals from different localities would merit investigation. In general, ordinary field collections as made by the writer contain too few individuals for population analyses.

In regard to the placement of *C. simpsoni* in the proper group of the genus Candona, the writer assigns this species to the group Rostrata because there are three setae in the bundle on the antepenultimate podomere of the mandibular palp and because the female genital lobe is poorly developed. However, the shell length is slightly greater than twice the height and the valves are relatively smooth, this being contrary to the

typical condition in the Rostrata group. This would tend to exclude this species from the group. The writer holds the opinion, however, that more consideration and weight should be given to the condition of the genital lobes of the female than to the ratio of height to length of shell. This is also apparently the opinion of European writers.

Ecology: Sharpe (1918) reports that *C. simpsoni* is a bottom form of lakes and river shores, and also ponds, while Furtos (1933) gives the habitat as "shallow weedy ponds and marshes." The majority of the writer's seventy collections of this species were made in grass or in masses of algae along the edge of ponds and sluggish streams. One individual was taken from the water in a crayfish burrow. The young of *C. simpsoni* may be taken from ponds before the prevernal break-up of the surface ice. Young individuals may be taken through much of the aestival season; the adults persist through autumn in habitats that do not dry up during the summer. In general, the individuals of this species are not taken in great numbers in most collections. Collections with as many as ten individuals, however, are not rare. In only two of the writer's seventy collections was this species found in numbers greater than ten. One of these collections contained twenty, the other about one hundred individuals. This last collection was made from a temporary pond in Woodford County, Illinois.

Distribution: Candona simpsoni appears to be the most common and widely distributed Candoninae in Illinois. Sharpe (1897) reported it from Havana and Urbana, Illinois. Kofoid (1908) also reported it from Havana, Illinois. The writer has taken it in collections throughout the state from Lake County on the north to Hardin and Johnson Counties on the south. Furtos furnishes the only record outside of Illinois in her reference (1933) to *C. exilis* in Ohio.

Group Compressa

More than three setae in the bundle on the inner margin of the antepenultimate podomere of the mandibular palp. Otherwise as in group Rostrata.

Only two species assignable to the group Compressa are known from Illinois: *C. albicans* Brady 1864 (*C. parallela* G. W. Müller 1900) and *C. biangulata sp. nov.*

KEY TO SPECIES OF THE GROUP COMPRESSA FROM ILLINOIS

a. Dorsal margin of shell straight without a sinuation between it and the anterior shell margin (fig. 18); anterior margin of shell broadly rounded; length of shortest distal seta of third leg is a little over twice the length of the ultimate podomere (fig. 19); length of terminal seta of furca less than the least width of the furcal ramus (fig. 20).....*C. albicans* Brady 1864

b. A sinuation between the dorsal and anterior shell margins (fig. 24); anterior margin of shell narrowly rounded; length of the shortest distal seta of third leg over three times the length of the ultimate podomere (fig. 27); terminal seta of furca equal to least width of ramus (fig. 28).....*C. biangulata sp. nov.*

Candona albicans Brady 1864

(Pl. II, figs. 18-23)

C. albicans Brady 1864. Brady, 1864:61, pl. 4, figs. 6-10; 1868:381-2, pl. 25, figs. 20-25 and pl. 36, fig. 12; Sars, 1928:82-83, pl. 39, fig. 1.
C. parallela G. W. Müller 1900. G. W. Müller, 1900:25, pl. 5, figs. 5, 6, 18, 19, 23-25; Sharpe, 1908:401-402, pl. 51, fig. 1-5; 1918:825, figs. 1297a, b, c, d; Furtos, 1933:486-487, pl. 12, figs. 18-20; Dobbin, 1941:241, pl. 3, figs. 11-13.

Type Locality: British Isles.

Description of the Female: Candona albicans of the Compressa group has a shell (fig. 18) sub-oval in lateral view. The dorsal margin is nearly straight, sometimes slightly sinuated, and almost horizontal, being nearly parallel to the ventral margin though often inclined somewhat posteriorly. The anterior margin is broadly rounded, the posterior is bluntly rounded. The greatest height is at the beginning of the posterior one-fourth of the shell and is more than one-half of the length. Measurements of the valves of two mature females from Illinois show a considerable variation in actual shell size (mounted in diaphane). These measurements are as follows:

Right		Left	
Length	*Height*	*Length*	*Height*
0.84 mm.	0.44 mm.	0.85 mm.	0.48 mm.
0.78	0.42	0.78	0.44

In dorsal view the shell appears elongated with the greatest width in the middle and somewhat less than the height. The posterior margin is rounded and the anterior is somewhat pointed when viewed from above. The valves show many hairs, especially along the anterior and posterior margins. The shell is covered with small pits, and this areolation is especially marked in the anterior and posterior thirds of the shell and in young individuals.

The two longest claws of the penultimate podomere of the antenna extend beyond the tip of the longest claw of the ultimate podomere. The mandibular palp has a smooth medial seta on the penultimate podomere and a bundle of four setae on the antepenultimate podomere. The penultimate podomere of the third thoracic leg (fig. 19-P) is divided, the shortest apical seta is slightly longer than twice the length of the ultimate podomere in American forms and slightly less in European specimens. The seta of the penultimate podomere is also longer than

in the European form. The furca (fig. 20) has a nearly straight posterior margin; both claws are somewhat bent throughout their length. The length of the ventral margin of the furcal ramus is between seven and eight times the least width; the length of the dorsal seta is over two times the least width of the ramus in Illinois specimens but less in the European. The terminal claw is less than one-half of the length of the furca while the terminal seta has a length less than the least width of the ramus. The genital lobe is not well developed; though inconspicuous, it has a hemispherical shape.

Description of the Male: The single male of *C. albicans* collected in Illinois has a shell (fig. 21) somewhat similar to that of the female but larger. The right valve measures 0.94 mm. long and 0.48 mm. high; the left valve slightly larger. The valves are not as high in relation to the length as in the female and the dorsal margin is not so flattened or horizontal. The right, but not the left, valve has a slight sinuation at the anterior end of the dorsal margin. The antenna, mandible, and thoracic legs are much as they are in the female. The length of the ventral margin of the furca is ten to eleven times the least width, being much more slender than in the female. The claws and the dorsal setae are also proportionally larger than in the female. The prehensile palps are slightly unequal but nearly similar. The left (fig. 22a) has a rather straight slender distal portion while the right (fig. 22b) is more falciform and stouter than the left. The penis (fig. 23) has less chitinized lobes than in many Candona species. The lobes are very flap-like and flimsy in appearance.

The occurrence of males is considered to be rare in this species. Furtos (1933) reports the male as being unknown. Sars (1928) reports that males are rare. He gives a description of the male whose shell differs little in size and shape from the shell of the female. The penis and prehensile palps of the male are said by Sars (1928) to be similar to those of *C. stagnalis* G. O. Sars 1891 in which the penis has "three well defined terminal lappets of nearly equal size, though somewhat differing in shape" (Sars, 1928) and the prehensile palps are unequal and dissimilar, the left being fairly straight and the right subfalcate (Sars, 1928:pl. 38, fig. 2).

Remarks: The *C. albicans* found by the writer agrees in most details with the European descriptions and is identical with the Ohio specimens described by Furtos (1933). The short apical seta of the third thoracic leg and the dorsal seta of the furca as well as the seta of the penultimate podomere of the third leg are longer than shown in the descriptions by European writers. The figures given by Sharpe (1908:pl. 51, figs. 3 and 5) for *C. parallela* are very close to the specimens found by Furtos in Ohio and those collected by the present writer. Apparently there is a slight

consistent difference between the European and the American forms. Until larger numbers of individuals are examined from many different localities, it is thought unwise to assign any new specific or even varietal designation to the American form.

For forty years the species under discussion has been known almost universally as *C. parallela* G. W. Müller 1900. After a thorough examination of the description of *Candona albicans* Brady 1864 (Brady, 1868), there is little doubt in the writer's mind that the species described by Brady in 1864 is the same as the one described by G. W. Müller in 1900. The chief apparent difficulty in establishing synonymy between *C. albicans* and *C. parallela* seems to be the smaller size of the former. In spite of this difference, a result of Brady possibly basing his description on immature individuals, Sars (1928) proves almost conclusively that *C. albicans* is the valid name. His arguments are founded on structural resemblances as well as surface sculpturing. Disregarding Sars's demonstration of the validity of *C. albicans,* Klie (1938a) tenaciously holds to the name *C. parallela;* he gives, however, *C. albicans* as a synonym of *C. parallela.* To retain *C. parallela* as the valid name under these circumstances is contrary to law of priority in the rules of nomenclature. Beyond all doubt, *C. albicans* is the valid name and must be retained for this species.

Ecology: The habitat of this species in North America seems to be identical with the habitat as recorded for Europe. Sars (1928) reports it as being common in small ditches and pools with muddy bottom. Klie (1938a) gives the habitat as temporary pools with muddy bottom and rich plant growths. Sharpe (1918) reports the habitat as "swampy ponds"; Furtos (1933) found the species in temporary and permanent pools and swamps in Ohio. The present writer secured some of his specimens from a small pool four feet in diameter and not over ten inches deep located just a few feet from the edge of Lake Vermilion at Danville, Illinois, on April 28, 1940. The bottom of the pool was of mud and grass was growing around the edge. Other collections of this species were made in July from temporary streams. *C. albicans* seems to be distinctly a vernal and early aestival form. The males are herein for the first time reported from North America. From the sparsity of the males, it is probable that reproduction in this species is almost entirely parthenogenetic.

Distribution: C. albicans has been reported from continental Europe and from the British Isles by numerous writers. That it is probably distributed widely in the United States is shown by the report from Colorado by Sharpe (1908), from Ohio by Furtos (1933), and from California by Dobbin (1941). It was obtained by the writer in four collections from Illinois: one from Vermilion County on April 28, 1940, and three from Carroll County on July 5, 1940.

Candona biangulata sp. nov.

(Pl. II, figs. 24, 25; pl. III, figs. 26-28)

Candona acuminata Sharpe 1897 (*non* Fischer 1851). Sharpe, 1897:449-451, pl. 44, figs. 5-7.

Type Locality: Illinois.

Description of the Female: A Candona of the Compressa group. From the side, the shell (fig. 24) is elongated; height slightly greater than one-half of the length. The greatest height of the shell is at the posterior end of the flattened dorsal margin. The right valve shows a ventral margin with a slight, even sinuation most marked near the center of the margin. The dorsal margin is very slightly concave, very slightly convex, or in most shells straight. Between the dorsal margin and the anterior margin is a pronounced sinuation. The anterior margin is narrowly rounded. A shallow sinuation lies between the dorsal margin and the posterior margin and in some individuals may be more or less obliterated. The posterior margin is rather broadly curved with a tendency for the arc to become slightly straightened on approaching the ventral margin. The left valve differs in shape distinctly from the right valve although the ventral margin is somewhat similar. The dorsal margin is convex and the sinuations between the dorsal margin and the anterior and posterior margins are not noticeable but may be expressed by a slightly flattened area near both ends of the dorsal margin. The left valve is slightly larger than the right, the height especially being greater. The subcentrally located muscle scars are six in number and display a definite arrangement in all the individuals examined. A single, oval to elongate isolated scar is dorsal to a group of five circular to oval scars arranged in an imperfect rosette. The ovary appears as an elongated, narrow band and reaches the level of the muscle scars. The pore-canals are very short and inconspicuous because the submarginal line is removed but a short distance from the shell margin. The valves are nearly devoid of hairs, though a few bristle-bearing puncta are scattered over the surface. The hairs of the anterior and posterior margins are short and weak. Measurements of the valves of three mature females from Illinois are as follows (mounted in diaphane):

Right		Left	
Length	*Height*	*Length*	*Height*
0.71 mm.	0.36 mm.	0.73 mm.	0.— mm. (holotype)
0.70	0.35	0.72	0.38
0.70	0.36	0.71	0.38

A dorsal view of the shell was not obtained but observations of mounted valves indicate that the width of the shell is probably one-fourth to one-fifth less than the height.

The antennules are composed of eight podomeres. The third and

fourth podomeres have a length approximate to the width. The distal four podomeres are much longer than wide, especially the ultimate podomere which is in the form of an elongated cylinder. The third podomere has a short seta equal to the width of the podomere; the fourth has no seta; the fifth has two long swimming setae; and the sixth has, in addition to two long swimming setae, a short seta equal to the width of the podomere. The seventh podomere has two long swimming setae and two short ones slightly less in length than the length of the podomere. The apical setae consist of a short, heavy seta equal in length approximately to the length of the ultimate podomere and two long swimming setae. The antennae consist of five podomeres. The medial side of the third (antepenultimate) podomere bears in addition to the regularly occurring sensory bristle a pair of setae, each slightly longer than the sensory bristle and separated from the distal margin of the podomere by a distance equal to one-half of the width of the podomere taken at the base of the setae. The penultimate podomere is shorter than the antepenultimate and bears two medial setae, one close to the distal margin and the other located proximally a distance equal to the width of the podomere. The penultimate podomere also has a short lateral seta close to the beginning of the distal one-third of the podomere. The ultimate podomere has a width slightly greater than one-half the distal width of the penultimate podomere. The longest claws of the penultimate podomere are equal to or extend slightly beyond the longest claw of the ultimate podomere. The teeth of the mandible are long and pointed; the mandibular palp (fig. 25) is characteristic of the Compressa group as the median seta on the penultimate podomere is unfeathered and there are four setae in the group (fig. 25-B) on the antepenultimate podomere. Eighteen rays are present on the branchial plate of each maxilla. The penultimate podomere of the palp of the maxilla is twice as long as the width measured in the distal one-third where the podomere is considerably widened.

The second thoracic leg (fig. 26) has a very large, heavy second podomere (fig. 26-A) whose length is equal at least to the combined lengths of the three more distal podomeres. The antepenultimate podomere and the penultimate podomere are subequal in length; the ultimate podomere (fig. 26-U) is conical with the length slightly greater than the width of the base. The second podomere has a short subterminal seta equal to the distally placed seta of the third or antepenultimate podomere. The seta of the penultimate podomere is approximately as long as, or longer than, the length of the last podomere. The claw (fig. 26-C) of the ultimate podomere is one and one-fourth to one and one-half times the combined length of the last three podomeres. The ultimate podomere also has two short setae, one of which is shorter than the length of the

distal podomere, the other somewhat longer. The third thoracic leg (fig. 27) has five apparent podomeres as the penultimate podomere is clearly divided. The apparent penultimate podomere bears a seta considerably greater in length than the length of the podomere. The ultimate podomere is nearly square in lateral view; the shortest distal seta is longer than the seta of the penultimate podomere and is over three times the length of the ultimate podomere. The longer distal seta of the pair is over one and one-half as long as its shorter companion and is about equal in length to the combined lengths of the three apparent distal podomeres of the third leg. The third distal seta is about one and one-fourth the length of the longer seta of the pair, although considerable variation is shown in the length.

The furca (fig. 28) has a relatively straight dorsal margin; the dorsal seta stands at the apex of a slight convexity; a small indentation in the dorsal margin between the proximal one-half and one-third of the dorsal margin indicates the deepest point in a slight concavity. The ventral margin of the furca is slightly but evenly curved. The least width of the ramus is equal to about one-seventh of the ventral margin. The dorsal seta has a length about two and one-half to three times the least width of the ramus and is located from the base of the subterminal claw a distance of at least twice the least width of the ramus. Both the subterminal and the terminal claws are similar in appearance, being gently curved, long, and slender. The subterminal claw is about six-sevenths as long as the terminal, while the terminal claw is more than one-half and less than two-thirds as long as the dorsal margin of the ramus. No indication of teeth or hairs could be found on the claws although observations were made under high magnification on both diaphane and glycerine mounted materials. The terminal seta is equal to the least width of the ramus. The female genital lobe (fig. 28-G) is small and cone-shaped; often it is distally drawn out papilla-like. The lobe does not extend posteriorly beyond the margin of the furcal rami.

Male: The male is unknown.

Remarks: It is rather difficult to compare *C. biangulata sp. nov.* with other forms of the group Compressa because of the imperfect nature of the literature concerning the external morphology of many forms. In only three previously reported species belonging to the Compressa group, as far as the writer has been able to determine, have four setae been definitely reported in the mandibular bundle. These species are: *C. albicans* Brady 1864, *C. hertzogi* Klie 1938 (Klie, 1938d), and *C. bilobata* Klie 1938 (Klie, 1938c). Of these three, *C. albicans* alone has a divided penultimate podomere in the third thoracic leg and, as a result, it is apparently related to *C. biangulata.* One of the species which has a questionable

number of setae in the mandibular bundle and which may be related to *C. biangulata* is *C. aemonae* Klie 1935 (Klie, 1935). Klie does not know for certain whether the bundle of setae on the antepenultimate podomere of the mandibular palp in *C. aemonae* has four or five setae. The third thoracic leg, the furca, and in part the genital lobe are similar to *C. biangulata.* Both *C. biangulata* and *C. aemonae* have two setae on the basal podomere of the third leg. On the other hand, the shape of the shell differs greatly in the two species. Whether or not the two species are closely related must await the determination of the number of setae in the bundle on the mandibular palp in *C. aemonae.*

The writer believes that the ostracod described by Sharpe (1897) under the designation of *C. acuminata* was not the *C. acuminata* of Fischer. That Sharpe himself realized his error is evident from the fact that he later (1918) does not give Illinois as a locality for *C. acuminata* Fischer. Although the shell described by Sharpe is slightly larger than that of *C. biangulata,* there is so much similarity between the description given for *C. acuminata* by Sharpe and the individuals of the present new species, that there can be little question but that they are the same. The present writer gives an entirely new description without reference to Sharpe's description because it is possible that Sharpe's description may be contaminated from European descriptions of *C. acuminata* Fischer.

Ecology: This species has been taken by the writer in five collections, each containing only one or two individuals. Two collections were from temporary streams, two from vernal ponds. The fifth collection was secured from water in a crayfish burrow. Sharpe (1897) collected his material from a pond. Obviously, this species lives in temporary waters where there is little or no current. It is usually found over a mud bottom.

Distribution: C. biangulata sp. nov. was secured by the writer from Champaign, McLean, Will, and Henry Counties, Illinois. Sharpe (1897) reported this species as *C. acuminata* from Clifton, Iroquois County, Illinois on May 12, 1882.

The holotype (female) of this species is deposited in the U. S. National Museum (Cat. No. 81067). One paratype (female) is in the collection of Dr. H. J. Van Cleave and others (female) are retained in the writer's collection.

Group Acuminata

Shell compressed, width usually about one-third of the length; height often but not always less than one-half the length; posterior end of shell broadly rounded (fig. 49) or obliquely subtruncate to truncate (fig. 40). Shell with few hairs. The medial seta of the penultimate podomere of the mandibular palp smooth; the bundle on the antepenultimate podomere

consists of four setae (fig. 43-S). The female genital lobe is well developed, pointed, and extends posteriorly between the furcal rami (figs. 32-G, 37-G). Outer lobe of the penis usually well developed and conspicuous (figs. 48-O, 57-O).

The group Acuminata appears to have reached a high degree of development in North America where there are many more species than in Europe. The exact number of North American species assignable to this group is unknown because the knowledge regarding the minute structure of many species is incomplete. The deficiency of information is especially acute in regard to the number of setae in the bundle on the mandibular palp. It is probable that many of the new species described by Furtos in 1933 belong to this group.

The present writer has definitely assigned eight species from Illinois to this group and two more are assigned tentatively until more details of the structure can be secured. The tentative assignment of these two species, *C. recticauda* Sharpe 1897 and *C. sharpei sp. nov.*, is based upon inadequate descriptions.

KEY TO SPECIES OF THE GROUP ACUMINATA IN ILLINOIS

1a. The antepenultimate podomere of the second thoracic leg is two-thirds as long as the penultimate podomere; the length of the longer companion distal seta of the third thoracic leg is more than three times the length of the shorter one.....*C. recticauda* Sharpe 1897

b. The antepenultimate podomere of the second thoracic leg as long or longer than the penultimate podomere; the length of the longer companion seta of the third leg is less than three times the length of the shorter of the pair (fig. 53-S).....2

2a. Ventral margin of furca not over eight times the least width of the furcal ramus.....*C. sharpei sp. nov.*

b. Ventral margin of furca over eight times the least width of the furcal ramus.....3

3a. Female genital lobe bifurcated, ventral part not as well developed as the dorsal branch (fig. 30-G).....*C. distincta* Furtos 1933

b. Female genital lobe not bifurcated but drawn out to a single point (fig. 37-G).....4

4a. Dorsal margin of shell forms a low arch without conspicuous sinuation or angulation (figs. 33, 36).....5

b. Dorsal margin of shell forms a high peak usually with, occasionally without, angulations, sinuations, or both (figs. 40, 49).....6

5a. Shell longer than 1.10 mm.; ventral margin of furcal ramus eleven times and the dorsal seta two times the least width of the ramus (fig. 35).....*C. caudata* Kaufmann 1900

b. Female shell less than 1.10 mm. in length; ventral margin of furcal ramus less than ten times and dorsal seta over three times the least width of the ramus (fig. 37).....*C. sigmoides* Sharpe 1897

6a. Length of the female shell over 1.25 mm.....*C. crogmaniana* Turner 1894

b. Length of female shell less than 1.25 mm.....7

7a. The dorsal margin of the shell high and rounded (fig. 40); outer lobe of penis distally divided (fig. 48-O); longer companion seta of third leg more than twice the length of the shorter of the pair (fig. 45)...*C. indigena sp. nov.*

b. The dorsal margin of the shell usually not high and well rounded; outer lobe of penis not distally divided; third thoracic leg with length of the longer companion distal seta equal to or less than twice the shorter of the pair (fig. 53-S).....8

8a. Posterior slope of shell of female sculptured (figs. 58, 59); female genital lobe long and finger-like (fig. 62).....*C. fossulensis sp. nov.*

b. Posterior slope of shell not sculptured; female genital lobe not finger-form...9

9a. Shell without posterior-ventral angulation (fig. 49); posterior end of shell rounded; female genital lobe not especially narrowed at junction with the thorax (fig. 54-G).....*C. suburbana sp. nov.*

b. Shell with posterior-ventral angulation (fig. 65); posterior end of shell subtruncate; female genital lobe narrowed at junction with the thorax (fig. 69-G).....*C. acuta sp. nov.*

Candona recticauda Sharpe 1897

Candona recticauda Sharpe 1897. Sharpe, 1897:451-452, pl. 46, figs. 7-11; 1918:826, figs. 1299a, b, c, d, e.

Type Locality: Clifton, Iroquois County, Illinois.

Description (after Sharpe, 1897): A Candona species tentatively assignable to the Acuminata group. "Shell of male 1.18 mm. long and .70 mm. high, stout." Both prehensile palps gently bent, the right much heavier than the left and ending in a hyaline point. Terminal claw of the second leg is one and one-half times as long as the sum of the lengths of the distal three podomeres; the antepenultimate podomere is two-thirds as long as the penultimate. The third thoracic leg has the penultimate podomere divided; the ultimate podomere is as long as wide, with the length of the shortest distal seta two and one-half times the length of the ultimate podomere. In Sharpe's figure 7, plate 46, however, the length of this seta appears about one and one-half times the length of the ultimate podomere. The companion seta is about three and one-half times the length of the shorter of the pair. "Caudal rami well developed, long, straight. Terminal claw half as long as the ramus, evenly and gently curved . . . . Dorsal seta three fifths the length of the subterminal claw and at two thirds its length from the claw; terminal seta a third the length of the dorsal one."

Remarks: This description by Sharpe appears to be based entirely on males. The present writer has found no specimens which could be identified as *C. recticauda* Sharpe. This species seems related to *C. indigena sp. nov.* from which it differs in the shape of the prehensible claws, the relative lengths of the antepenultimate and penultimate podomeres of the second thoracic leg, and the length of the short seta of the ultimate podo-

mere of the third thoracic leg. Since Sharpe gives neither a description nor a figure of the shell, accurate identification of specimens belonging to *C. recticauda* may be difficult. For the present, *C. recticauda* should be considered a valid species.

Ecology: Sharpe (1897) secured his type specimens from a pond.

Distribution: The only available record for *C. recticauda* is that of the type specimens from Clifton, Iroquois County, Illinois (Sharpe, 1897).

Candona sharpei sp. nov.

Candona fabaeformis Sharpe 1897 (*non* Fischer 1851). Sharpe, 1897:454-455, pl. 45, figs. 1-3.

Candona fabaeformis (part?) Sharpe 1897 (*non* Fischer 1851). Sharpe, 1918:826, figs. 1300a, b, c, d.

Type Locality: (*C. fabaeformis* Sharpe 1897) Normal, McLean County, Illinois.

Description (after Sharpe, 1897): A Candona species possibly belonging to the group Acuminata. "Length 1.00 mm., height .47 mm., width .49 mm. . . . . Seen from the side, it is slightly widest back of the middle, the upper and lower edges nearly parallel, both ends fully rounded, the ventral edge quite deeply sinuate near the middle." Terminal claws of the female antenna scarcely longer than last two podomeres. The penultimate podomere of the third leg divided. "Terminal segment as long as broad, one half as long as the penultimate segment, which is twice as long as broad. Shorter terminal seta twice as long as the terminal segment and a third as long as the longer similarly directed seta; reflexed seta but slightly longer than the longer terminal one." The furca is seven times as long as wide; terminal claw one-third as long as the ramus. The terminal seta is as long as the ramus is wide; "dorsal seta four-fifths as long as the subterminal claw, and distant twice the width of the ramus from it."

Remarks: This species, which has been renamed *C. sharpei sp. nov.*, cannot possibly be the *C. fabaeformis* of Fischer. G. W. Müller (1912) doubted Sharpe's designation of this form. By the shell width alone, it is possible to see that Sharpe's species is not *C. fabaeformis* Fischer. The species described by Sharpe under *C. fabaeformis* had a shell width of one-half the length while the *C. fabaeformis* of Fischer has a shell width of not over one-third of the length (G. W. Müller, 1900; Klie, 1938a; *et alli*). Also the furca in Sharpe's species is much stouter, having a length of less than seven times the width, while in Fischer's *C. fabaeformis* the furca is elongated and has a length of at least eleven times the least width.

Sharpe apparently studied only female shells as he does not mention the male, and in particular the prehensile claws. However, he pictures the right prehensile claw (1918:fig. 1330d) at a later time. It is entirely possible that this illustration was borrowed from European descriptions of the true *C. fabaeformis*. In regard to Turner's report (1895) of *C. fabaeformis* in Georgia, it is apparent (*Cf.* G. W. Müller, 1912) from a study of the shell characters that it is also not assignable to *C. fabaeformis* of Fischer. At the same time, it is doubtful if the specimens described by Turner (1895) and Sharpe (1897) belong to the same species as they appear to differ in many respects.

A definite assignment of *C. sharpei sp. nov.* to any certain group of the genus Candona is of course impossible. If one knew for certain that Sharpe (1918:fig. 1300d) pictured the right prehensile palp from an Illinois individual, there would be little hesitancy in referring this species to the group Fabaeformis. Moreover, assignment to any group is difficult because the condition of the female genital lobe is unknown. In general appearance, the writer suspects that the species probably belongs to the Acuminata group and is related to such forms as *C. acuta* and *C. sigmoides*. It is entirely possible that Sharpe based his species diagnosis on immature individuals. At any rate, the writer is of the opinion that *C. sharpei sp. nov.* should be carried in the literature until the Candoninae of the state are better known and the variation occurring within species is understood. It may then be possible to place this species.

Ecology: Sharpe (1897) reports this species from a pool.

Distribution: The only certain reference to *C. sharpei sp. nov.* is that of Sharpe (1897) who reported it under the name *C. fabaeformis* from Normal, Illinois on March 27, 1881.

Candona distincta Furtos 1933

(Pl. III, figs. 29-30)

Candona distincta Furtos 1933. Furtos, 1933:478-479, pl. 8, fig. 15; pl. 9, figs. 13-16; pl. 12, figs. 21-22.

Type Locality: Ohio.

Description of the Female: A Candona of the Acuminata group (fig. 29). "From the side: elongated, height about one-half the length; extremities rounded, the posterior narrower; ascending slope of the dorsal margin moderately arched, with a distinct sinuation in the middle giving the appearance of two dorsal humps, the posterior of which is the higher; descending slope of dorsal margin almost straight; ventral margin sinuated; submarginal line removed from the mid-central and

posterior margins" (Furtos, 1933). The measurements of valves of two females from Illinois mounted in diaphane are:

Right		Left	
Length	*Height*	*Length*	*Height*
0.92 mm.	0.47 mm.	0.93 mm.	0.49 mm.
0.97	0.50	0.98	0.52

The penultimate podomere of the third leg is divided. In the material from Illinois, the shortest distal seta of the third thoracic leg is nearly four times the length of the ultimate podomere while the companion seta is slightly under two and the oppositely directed seta slightly over two times the length of the shortest seta. The ventral margin of the furca (fig. 30) is eight or nine times the least width of the furcal ramus; the length of the dorsal seta is about three times and the length of the terminal seta about one and one-fourth times the least width of the ramus. The dorsal seta is removed from the subterminal claw by a distance equal to three times the least width of the ramus. "Genital lobes moderately developed, proximal portion rectangular, slightly longer than broad, distal process somewhat forked, the ventral branch barely developed" (Furtos, 1933).

Description of the Male: "Male larger than the female, left valve larger than the right, projecting beyond it at each extremity, sinuation of dorsal margin less pronounced, ventral margin with a small anterior hump, behind which the sinuation is deeper than in the female" (Furtos, 1933). The sizes of valves of three males from Illinois (mounted in diaphane) are as follows:

Right		Left	
Length	*Height*	*Length*	*Height*
1.00 mm.	0.53 mm.	1.01 mm.	0.54 mm.
1.02	0.56	1.04	0.57
1.05	0.55	1.07	0.56

Remarks: The Illinois material agrees precisely with the original description of Furtos (1933).

Ecology: Furtos (1933) reported this species as common in marshes, canal basins, and small lakes. The present writer collected his specimens from a small temporary prairie pond and a grassy roadside ditch. Like many other Candona species, this form is apparently vernal in seasonal distribution.

Distribution: Furtos (1933) reported *C. distincta* from several localities in Ohio. The present writer's collections were secured from Seymour Prairie, Champaign County, on April 1, 1940, and from the same vicinity but in Piatt County, Illinois, on May 4, 1940.

Candona crogmaniana Turner 1894

(Pl. III, figs. 31-32)

Candona crogmaniana Turner 1894. Turner, 1894:20-21, pl. 8, figs. 24-33; Furtos, 1933:476, pl. 8, figs. 1-3; pl. 9, figs. 17-18; pl. 11, figs. 9-10.

Candona crogmani Turner 1895. Turner, 1895:300-301, pl. 71, figs. 24-33; pl. 81, figs. 4-5; Sharpe, 1918:824, figs. 1295a, b, c.

Type Locality: Atlanta, Georgia.

Description of the Female: A Candona of the Acuminata group. "From the side: elongated, subtriangular, height less than one-half the length, highest in the posterior third; anterior extremity broadly rounded, the posterior narrow; ascending slope of dorsal margin gently arched, with an anterior sinuation, descending slope steep; ventral margin sinuated" (Furtos, 1933). The shell (fig. 31) is large; valves of three mature females from Illinois (mounted in diaphane) measure as follows:

Right		Left	
Length	*Height*	*Length*	*Height*
1.32 mm.	0.65 mm.	1.37 mm.	0.68 mm.
1.41	0.68	1.45	0.70
1.28	0.63	1.33	0.65

The mandibular palp has the medial-distal seta of the penultimate podomere smooth and has four setae in the bundle on the antepenultimate podomere. The penultimate podomere of the third thoracic leg is divided; the distal podomere is nearly as wide as long; and the shortest distal seta is four times the length of the distal podomere. The companion seta is two and one-half times as long as its shorter mate, and the oppositely directed seta is three times as long as the shortest distal seta. The furca is gently curved; the ventral margin is twelve to thirteen times the least width. The dorsal seta has a length of over four times the least width of the ramus and is removed from the subterminal claw by a distance equal to almost four times the least width of the ramus. The terminal claw has a length approximate to one-half of the length of the ventral margin of the ramus while the terminal seta has a length approximate to twice the least width of the ramus. The genital lobe (fig. 32-G) consists of a long finger-like projection extending posteriorly and dorsally from a bulbose base.

Description of the Male: With the exception that the shell size is slightly larger in the male than in the female and that the shape is somewhat different, the anatomical details of the male and the female are the same. No males were observed by the writer in his material collected in Illinois. The reader is referred to Furtos's description of the male (Furtos, 1933).

Remarks: Furtos is correct in assigning to this species the older name

given by Turner instead of the later name, *Candona crogmani,* which Turner tried to introduce in 1895. He probably thought that *crogmani* was a much simpler name and orthographically more correct than *crogmaniana.* The original name must stand, however, as the valid designation for this species.

Ecology: Turner (1894) collected the original lot of specimens from shallow ponds near South River, Atlanta, Georgia. Turner (1895) describes these ponds as "drying up in warm weather." Furtos (1933) collected *C. crogmaniana* from both permanent and temporary ponds. The present writer has taken this species along the edge of a permanent pond (ox-bow) both from masses of floating algae and from dead leaves and grass on the bottom.

Distribution: Candona crogmaniana was collected by Turner (1894) from near Atlanta, Georgia; by Furtos (1933) from several places in Ohio; and by the present writer from near Muncie, Vermilion County, Illinois. The writer's two collections came from Muncie pond on April 28, 1940.

Candona caudata Kaufmann 1900

(Pl. III, figs. 33-35)

Candona caudata Kaufmann 1900. Kaufmann 1900a:365-368, pl. 24, figs. 16-20; pl. 26, figs. 17-23; Sars, 1928:76-77, pl. 35; Klie, 1938a:68, figs. 223-225.
Candona elongata G. W. Müller 1912 (*non* Herrick 1879). G. W. Müller, 1912:140.

Type Locality: Switzerland, Europe.

Description of the Female: "Shell rather elongate, seen laterally, narrow reniform in shape, with the greatest height not nearly attaining half the length, dorsal margin gently arched, without forming any distinct angular bend either in front or behind, posterior obliquely produced and exerted to a rather prominent peculiarly deflexed corner more fully developed on the left valve, this corner being however quite obsolete in immature specimens;—seen dorsally, narrow elliptical in outline, with the greatest width only slightly exceeding one-third of the length, both extremities obtusely pointed" (Sars, 1928) (fig. 33). Measurements of mature females (valves mounted in diaphane) from Illinois are as follows:

Right		Left	
Length	*Height*	*Length*	*Height*
1.26 mm.	0.60 mm.	1.31 mm.	0.63 mm.
1.30	0.60	1.34	0.62
1.26	0.60	1.30	0.61
1.10	0.50	1.13	0.51

The valves are sparsely haired and are marked by minute elevated areas separated by fine grooves. The pore-canals are rather conspicuous.

That this species belongs to the Acuminata group is evidenced by the fact that the medial-distal seta of the penultimate podomere of the mandibular palp is smooth and there are four setae in the group on the antepenultimate podomere of the same palp. The antennules and the antennae are stouter and heavier than in many of the Candona; the distal claws of the antennae are spine-like and the setae of the antennules are short. The respiratory plate of the maxilla has twenty-two rays or setae, four of which are directed orally. The second thoracic leg has clusters of small hairs and isolated spines along the sides of the second, third, and fourth podomeres. The third thoracic leg (fig. 34) has the penultimate podomere divided; the seta of the penultimate podomere is shorter than the shortest distal seta of the appendage. The ultimate podomere is nearly square; the shortest seta is about four times the length of the ultimate podomere. The longer seta of the similarly directed pair is one and one-half times as long as its shorter companion while the oppositely directed seta is nearly twice as long as the shortest distal seta.

The length of the ventral margin of the furca (fig. 35) eleven times the least width; the length of the dorsal seta twice the least width; and the terminal seta about the same length as the ramus is wide. The terminal claw has a length about equal to one-half of the length of the furca and the dorsal seta is separated from the subterminal claw by a distance approximate to one-third of the length of the ventral margin of the ramus. A short but conspicuous seta is located on the body dorsal to the furca. The genital lobes form a prominent conical lappet.

Male: The male is unknown both in Europe and in the material collected by the present writer (*Cf.* Sars, 1928; Klie, 1938a).

Remarks: There can be little question but that this is the *Candona caudata* described by Kaufmann. There seem, however, to be a few minor differences between the American specimens and the description given by Kaufmann. The shell of the American form is often slightly higher in proportion to the length. All of the setae of the third thoracic leg appear to be longer in relation to the length of the podomeres in American than in European forms but the ratios between the various setae lengths are about the same. One of the most conspicuous differences between the specimens from Illinois and the original specimens described by Kaufmann (1900a) is in the dorsal seta of the furca. In the type material, Kaufmann describes the dorsal seta as being feathered. The American specimens have a smooth and perhaps a little longer dorsal seta than that described from European material. That the smooth condition is common in Europe, where it is considered of insufficient importance to separate species, is evidenced by both Alm (1916) and Sars (1928) who figure a smooth dorsal seta. As the differences between the American and

European individuals are so slight and within the acknowledged range of individual variability, the writer does not hesitate to place the Illinois specimens in the species *C. caudata* Kaufmann.

A comparison of *C. caudata* with several closely related species is given in the "remarks" under *C. acuta sp. nov.,* described herein.

Ecology: European writers (Kaufmann, 1900a; Sars, 1928; *et alli*) report *C. caudata* chiefly from canals and lakes. Of the four collections of this species made by the writer, two came from silt bottomed drainage ditches with grass, weeds, and algae along the edge; the third from a permanent pond (ox-bow); and the fourth was taken from the stomach of a fish, *Catostomus commersonii,* taken from the stripland ponds near Oakwood, Illinois.

Distribution: Candona caudata Kaufmann 1900 is one of the common species of Europe and is well distributed over central and northern Europe as well as the British Isles. The present report is the first from North America. The writer's collections of this species were all from Vermilion County, Illinois.

Candona sigmoides Sharpe 1897

(Pl. III, figs. 36-38)

Candona sigmoides Sharpe 1897. Sharpe, 1897:455-456, pl. 45, figs. 4-11; Kofoid, 1908:258; Sharpe, 1918:825, figs. 1298a, b, c, d.

Type Locality: Mason County, Illinois.

Description of the Female: A Candona of the Acuminata group in which the shell height is nearly equal to one-half of the length. The valves of the shell differ somewhat in lateral view. The left valve (fig. 36) is the larger both in length and height; the greatest height is in the posterior one-third of the valve. The dorsal margin of the left valve is fairly evenly arched passing into the anterior and posterior margins without pronounced sinuation or angulation. The angulation formed by the posterior and ventral margins is distinct and projects somewhat into a weak point, just anterior of which is a slight sinuation of the ventral margin. The anterior end is somewhat narrowly rounded. There is a sinuation in the center of the ventral margin with a convexity located about one-half the distance from the ventral sinuation to the posterior-ventral point. The right valve is somewhat different in shape. There is a well marked sinuation between the dorsal margin and the anterior margin; there is a slight angulation at the juncture of the dorsal and posterior margins and the posterior-ventral point is not as well developed. There is also less of a convexity in the ventral margin between the ventral sinuation and the posterior-ventral point which is very weakly pronounced in the right shell half.

Measurements of the valves of three mature females from Illinois are as follows (mounted in diaphane):

Right		Left	
Length	*Height*	*Length*	*Height*
1.04 mm.	0.52 mm.	1.06 mm.	0.56 mm.
1.05	0.52	1.07	0.54
1.02	0.52	1.06	0.54

The shell surface is smooth with a few scattered hairs. These are best developed around the posterior-ventral point and along the anterior margin. The submarginal line is close to the margin so that the pore-canals are very short. There is a group of five muscle scars arranged in a rosette with a single scar just anterior to the group. There are also two pairs of scars: a pair of very small scars located some distance anterior-dorsal from the group, and another pair, each of which is well separated and large, located a little distance anterior and ventral of the group. A view of the shell from above was not obtained.

The antennules are stout with many of the podomeres appearing square in side view; the setae of the antennules are much shorter and heavier than in most Candoninae. The antennae are short and stout. The outer margin of the penultimate podomere of the antenna bears a seta almost in the center of the margin; the antepenultimate podomere bears a pair of medial-distal setae which extend past the base of the distal claws. The mandibular palp has the medial seta on the penultimate podomere smooth and the bundle on the antepenultimate podomere consists of four setae.

In the second thoracic leg, the distal claw is equal to the sum of the lengths of the last three podomeres. The ultimate podomere is more nearly cylindrical than conical and is over one-half as long as the penultimate podomere. The third thoracic leg has the penultimate podomere divided; the ultimate podomere is square and its shortest distal seta has a length nearly four times the length of the podomere. The seta of the penultimate podomere is as long as the sum of the lengths of the apparent penultimate and antepenultimate podomeres and about one-fourth again as long as the shortest distal seta. The distal seta, companion to the shortest one, is about two and one-fourth times as long as the short seta and the oppositely directed one is about the same length as the longer of the pair. The basal podomere of the third thoracic leg has two setae. The furcal rami (fig. 37) are considerably curved; the ventral margin of each measures nine or nine and one-half times the least width. The dorsal seta has a length of three and one-fourth times the least width of the ramus and is located from the subterminal claw a distance equal to three times the least width. The terminal seta (fig. 37-S) has a length

of one to one and one-third times the least width of the ramus. The terminal claw is approximate to one-half the length of the ventral margin of the furca. The claws are stout and in most specimens are slightly S-shaped, especially the subterminal claw (fig. 37-C). The genital lobe is elongated, almost finger-like, and extends posteriorly between the furcal rami (fig. 37-G).

Description of the Male: The shell of a mature male measured 1.20 mm. in length and 0.61 mm. in height. Sharpe (1897) gives the size as 1.25 mm. long and 0.63 mm. high. The single intact male shell of the writer's collections agrees with the description given by Sharpe: "the shell of the male is much higher posteriorly, the greatest height being about half the length; anterior extremity evenly rounded, narrow; posterior sloping ventrally. Dorsal margin rather evenly rounded; ventral, deeply sinuate anterior to the middle of the shell" (Sharpe, 1897). As this single mature male with the shell intact had been dead for some time, it was impossible to secure from it any details of the appendages beyond those given by Sharpe (1897). In another male, however, the appendages were in such condition as to allow a comparison with the description given by Sharpe. In addition to the observations given by Sharpe, the writer found that the penis (fig. 38) is oval in shape and widened in the center. The outer lobe is conspicuous; the two distal lobes small. Besides differing in the shape and size of the shell, the male differs from the female chiefly in the shape of the furca which is much straighter and distally narrower in the male.

Remarks: While Sharpe based his original description of *C. sigmoides* on male specimens and the present writer found only two mature males for comparison, it is evident especially through the shape of the furcal claws that the females seen by the writer belong to this species. One of the mature male specimens occurred in a collection in which were two mature females as well as several immature young males possibly also belonging to this species, but too insufficiently developed to merit identification or description.

Ecology: Sharpe (1918) reports *C. sigmoides* from lake and river shores. The present writer found it in algae hanging in the slow current of a small permanent stream three feet wide and in water plants along the edge of two small sluggish permanent streams.

Distribution: Sharpe (1897) collected his specimens of *C. sigmoides* at Havana, Illinois, and Kofoid (1908) reported the species from the same locality. The present writer has taken the species in Lake County on June 29, 1940; in Tazewell County on August 29, 1940; and in Knox County on June 14, 1940. This species has not been reported outside of the State of Illinois.

Candona indigena sp. nov.

(Pl. III, fig. 39; pl. IV, figs. 40-48)

Type Locality: Illinois and Tennessee.

Description of the Female: A Candona species of the Acuminata group. The holotype (fig. 39) in alcohol measured 1.08 mm. in length, 0.59 mm. in height, and 0.52 mm. in width. The width is little less than 90% of the height. Measurements of left valves of six females including several paratypes as well as the holotype after mounting in diaphane were:

Length	*Height*
1.04 mm.	0.60 mm. (holotype)
0.96	0.56
0.97	0.58
0.96	0.55
1.00	0.55
1.10	0.65

The right valve (fig. 40) of the shell of the female is not as high as the left, being usually 0.02 to 0.03 mm. less. The anterior margin of the shell is somewhat evenly rounded, blending into the dorsal margin without much conspicuous change in the arc. The highest part of the left shell is at the beginning of the posterior one-fourth in most shells, slightly anterior to this in a few individuals. At the beginning of the posterior one-fourth, a very distinct angulation is formed by the curved dorsal margin and the abruptly subtruncated posterior margin. The posterior-ventral angulation approaches more a right angle than one of sixty degrees. The ventral margin is slightly but distinctly sinuated; the submarginal line is relatively removed from both the posterior-ventral and the anterior-ventral margins; the pore-canals are very conspicuous, especially along the anterior-ventral and the posterior-ventral margins. From above (fig. 42): ovoid, slightly less pointed posteriorly than anteriorly; the left valve slightly overlapping the right at both ends. The sides make a very even and uninterrupted arc; widest in the area just behind the midpoint and considerably posterior to the attachment place of the closing muscles. Bristles of the dorsal posterior margin usually very long and heavy; finer bristles at the ventral posterior margin and along the anterior margin. The surface of the shell bears a few scattered puncta with hairs. The muscle scars are subcentral, usually slightly ventral and anterior from the center of the shell. There is normally a curved anterior row of four scars with two additional scars just posterior to the ventral two of the row. There may be two weak, separated scars ventral and anterior to the group of six.

The antennules consist of eight podomeres; podomere three is distinctly wider than long; podomere four is slightly wider than long, being

much shorter than the more distal podomeres. Podomere five is one and one-half times as long as wide. The ultimate (eight) and antepenultimate (six) podomeres are equal in length to the fifth, while the length of the penultimate podomere is one and one-half the length of the fifth. Antennae of five podomeres in the female. Two of the claws of the penultimate podomere are equal or subequal to the longest one of the claws of the last podomere. The shorter terminal claw is six-sevenths or seven-eighths as long as the other and extends beyond the shortest claw of the penultimate podomere. The ultimate podomere is about three-fifths as wide as long. The teeth of the chewing edge of the mandible (fig. 43-C) are elongated, heavily chitinized, and distinctly separated from each other even at the base. The palp is characteristic of the Acuminata group with the seta of the medial side of the penultimate podomere unfeathered and having a group of four setae (fig. 43-S) on the inner margin of the antepenultimate podomere. The branchial plate of the maxilla has twenty-four rays, the first five of which are directed toward the mouth. One seta of the third maxillary process is larger than the rest and not toothed.

The branchial plate (exopodite) of the first thoracic leg is reduced to two setae. One of these is rather stout and over 60 μ long, the other is weak and just a little more than one-fourth the length of the first. The second thoracic leg (fig. 44) is composed of five podomeres. Near the apical border of the second podomere is a seta approximately equal in length to the width of the podomere. The length of the second podomere is about equal to the sum of the lengths of the three more distal podomeres. The antepenultimate and penultimate podomeres are subequal in length and each is about five-eighths as wide as long. Each of these podomeres has a seta which is not quite equal in length to the podomere. The penultimate podomere also has a very small seta whose base is near the base of the larger one. The ultimate podomere is conical and tapers evenly to the apical claw. One of the two apical setae is equal in length to the apical podomere and the other is one-half as long. The apical claw is equal in length roughly to one and one-fourth times the sum of the last three podomeres of the appendage.

The third thoracic leg (fig. 45) clearly appears to be formed of five podomeres. There are no setae on the second and the apparent antepenultimate podomeres. The seta of the penultimate podomere and the shortest seta of the ultimate podomere are not more than gently curved and are not bent distally. In relation to the shortest seta of the apical podomere, the companion seta is about two and one-fourth to two and one-half times the shortest in length; while the oppositely directed seta is only two to two and one-fourth times as long. The apical podomere is about as long as wide.

The furcal ramus (fig. 46) of the female has a straight dorsal margin and a slightly curved ventral margin. The ratio of the least width of the base of the furca to the length of the ventral margin is about 1:9. The dorsal seta is three and one-half times the least width of the base of the furca and is removed from the subterminal claw by a distance more than twice the least width of the ramus. The subterminal claw measures in length nearly five times the width of the ramus; while the terminal claw is about one-half of the length of the dorsal margin of the ramus. The terminal seta is small, measuring about one and one-half times the least width of the ramus. Both claws are curved at the tips, rather slender, and are toothed especially in the middle third. The female sexual lobe (fig. 46-G) is moderately developed, being in the form of a narrow cone or papilla extending finger-like between the furcal rami but usually not beyond the dorsal margin of the rami. The ventral margin of this lobe is somewhat concave, while the dorsal margin is nearly straight.

Description of the Male: The shell of the male is nearly like that of the female when viewed from above. From the side (fig. 41), however, the ventral margin is usually more concave and the posterior margin is more rounded with a less conspicuous posterior-ventral point. The allotype measured 1.08 mm. long, 0.61 mm. high, and 0.54 mm. wide in alcohol. Measurements of the left valve of two males mounted in diaphane are as follows:

Length	*Height*	
1.04 mm.	0.59 mm.	(allotype)
1.04	0.60	(paratype)

The appendages of the male differ little from those of the female. The antenna has six podomeres but the end claws are very similar to those of the female. The prehensile palps of the first thoracic leg are dissimilar and unequal, the left (fig. 47b) being longer than the right (fig. 47a). Both are slightly curved distally and each has a distal seta and a medial one. The medial one is located more than one-third of the distance from the distal end of the left palp, less than one-third of the distance in the right palp. The penis (fig. 48) is widened distally and the outer lobe is unequally bilobed (fig. 48-O).

Remarks: Although the shell in this species is slightly higher than one-half of the length, there can be little doubt that it is distinctly a member of the Acuminata group. This species not only possesses the characters recognized as belonging to members of the group Acuminata but it also bears a close resemblance to some of the European members assigned to the Acuminata group. The posterior margin of the shell is oblique or truncate and shows a posterior-ventral angle similar to *C. levanderi* Hirschmann 1912 (Hirschmann, 1912), and *C. lapponica*

Ekman 1908 (Sars, 1928) from Europe. In size *C. indigena* is larger than *C. lapponica* but a little smaller than *C. levanderi.*

Ecology: Candona indigena is an inhabitant of temporary ponds where it seems to be well adapted to living in masses of decaying leaves and vegetation on otherwise more or less bare bottom in rather shallow water. As this species is distinctly an inhabitant of temporary ponds and sloughs, it is taken only during the vernal season.

Distribution: This species has been taken in three collections from east central Illinois: two collections from Seymour Prairie, Champaign County, on April 15, 1940, and one from Busey's Pasture, Urbana, Champaign County, on the same date. Two individuals were collected near Congerville, Woodford County, on May 28, 1940, and a few individuals of this species were found in a collection made by Robert Yapp from a slough near Reelfoot Lake, Tennessee, on March 22, 1940.

The holotype (female) and allotype (male) of this species are deposited in the U. S. National Museum (Cat. Nos. 81070 and 81071). Paratypes are in the collections of Dr. H. J. Van Cleave, Dr. Arthur G. Humes, and the writer.

Candona suburbana sp. nov.

(Pl. IV, figs. 49-54; pl. V, figs. 55-57)

(?) *Candona elongata* Herrick 1879 *sp. indet.* Herrick, 1879:113, pl. 20, figs. 2, 2a, b, c.

Type Locality: Busey's Pasture, Urbana, Champaign County, Illinois.

Description of the Female: A Candona species belonging to the Acuminata group. The shell (fig. 49) of the single female (allotype) examined is elongated, over twice as long as high. After mounting in diaphane, the right valve measures 1.04 mm. in length and 0.47 mm. in height; the left valve, being considerably larger, measures 1.08 mm. in length and 0.51 mm. in height. The width is about four-fifths of the height. The ventral margin has a sinuation in the posterior part of the anterior one-half of the shell; the anterior end is slightly more evenly and broadly rounded than the posterior end. In the left valve, the dorsal margin is nearly evenly rounded, passing more or less insensibly into the anterior and posterior margins although a very slight sinuation is indicated in the dorsal margin and between the dorsal and anterior margins. In the right valve, on the other hand, the sinuation of the dorsal margin and those between the dorsal and anterior and dorsal and posterior margins are more evident.

The surface of the shell bears a considerable number of short, weak hairs each of which is set on a well marked papilla. The hairs of the anterior and posterior margins are few in number and are weakly de-

veloped. Pore-canals are conspicuous at both ends as well as along the ventral margin. The muscle scars are somewhat anterior of the center of the shell and are very definite in arrangement. There are five scars forming a rosette with a single isolated one above the group and two isolated scars slightly anterior-ventral to the rosette.

The distal five podomeres of the antennules become regularly longer and narrower distally; the fifth and sixth podomeres have an outer seta longer than the length of the next podomere; the fifth, sixth, and seventh podomeres each has two long medial swimming setae. Distally, the eighth podomere bears two setae longer than one and one-half times the length of the podomere, one seta about half again as long as the short ones, and a very long swimming seta. The antennae have a group of four setae on the distal one-third of the penultimate podomere; the longest distal claw extends but little if any beyond the longest claw of the penultimate podomere. The medial distal seta of the penultimate podomere of the mandibular palp is smooth; there are four setae in the group on the antepenultimate podomere. The mandibular teeth consist of five very heavy teeth and two or three small, rudimentary teeth. Of the twenty-two rays in the branchial plate of the maxilla, four are directed orally.

The second leg (fig. 52) has the second podomere almost equal in length to the sum of the lengths of the third and fourth podomeres. The second podomere bears a distal seta shorter than the distal width of the podomere. The third and fourth podomeres are approximate in length with the distal seta of each, about equal in length to the length of the ultimate podomere of the appendage. The ultimate podomere is nearly twice as long as wide and bears distally a short seta about equal in length to the podomere, another three-fourths as long, and a claw slightly subequal in length to the sum of the lengths of the distal three podomeres of the appendage. The third thoracic leg appears to be formed of five podomeres through the division of the penultimate. The basal podomere bears two seta. The apparent second and third podomeres seem to bear no setae; the seta of the penultimate podomere is longer than the length of the podomere. The ultimate podomere is nearly square. The length of the shortest distal seta is four times the length of the ultimate podomere and is about one-half the length of the longer companion seta. The oppositely directed seta has a length about two times that of the shorter seta of the pair.

The furcal rami are nearly straight. The length of the ventral margin of the ramus is about eleven times the least width; the length of the dorsal seta is three and one-half to nearly four times the least width of the ramus and is located about one-third of the length of the dorsal margin from the distal end of the ramus. The finely toothed terminal

claw is about one-half as long as the ramus. The length of the terminal seta is about one and one-half times the least width of the ramus. The genital lobe (fig. 54-G) is moderately well developed, being triangular and lacking the long finger-like projection often seen in members of the Acuminata group. The genital lobes do not extend beyond the dorsal margin of the furcal rami.

Description of the Male: The shell (fig. 50) of the male is slightly larger than that of the female. Measurements of valves mounted in diaphane are as follows:

Right		Left	
Length	*Height*	*Length*	*Height*
1.00 mm.	0.— mm.	1.12 mm.	0.56 mm. (holotype)
1.13	0.55	1.16	0.58
1.12	0.52	1.16	0.54

The ventral margin is much more deeply sinuated than in the female shell. The dorsal margin, as a rule, is regularly and evenly arched and passes insensibly into the anterior and posterior margins. There are no evidences of sinuations in the center or at the ends of the dorsal margin except a slight dorsal flattening, which occurs in a few valves. A dorsal view (fig. 51) of the shell shows the sides to be rather evenly rounded and the ends somewhat pointed, the anterior more so than the posterior.

The antennules, mandibles, and maxillae are similar to those of the female. The antennae are slightly different in having lost the group of four setae on the penultimate podomere and in having acquired the customary heavy male seta at the distal end of the antepenultimate podomere. The second thoracic leg of the male differs from that observed in the female as follows: the second podomere is almost equal in length to the sum of the lengths of the three distal podomeres, the third podomere is slightly longer than the fourth, the seta of the third podomere is a little longer than in the female, and the terminal claw is slightly longer in relation to the length of the ultimate podomere. As the description of the female is based upon a single specimen, it is difficult to determine whether or not the slight differences between male and female appendages are the result of individual variation or are sexual differences. The third thoracic leg of the male (fig. 53) is essentially like that of the female.

The furca (fig. 55) of the male is more slender than the furca of the female and somewhat curved so that the ventral or anterior margin is slightly convex. The length of the ventral margin is nearly fourteen times the least width of the furcal ramus. The dorsal seta is located one-third of the length of the dorsal margin from the distal end of the furca.

The length of the dorsal seta is over four times the least width of the ramus, being about one-half as long as the terminal claw which, in turn, is about one-half as long as the ventral margin of the furcal ramus. The length of the terminal seta is twice the least width of the ramus. There is a very slight tendency in some instances to have an S-curvature in the terminal claw and more especially in the subterminal claw. This curvature is not pronounced.

The prehensile palps are unequal and somewhat similar; the right (fig. 56b) being rather large and stout, the left (fig. 56a) smaller and with a widening at the distal end. The penis (fig. 57) is oval in general outline, with prominent outer lobe (fig. 57-O).

Remarks: Because of the number of both American and European species belonging to the group Acuminata, it is difficult to establish a definite relationship between *C. suburbana sp. nov.* and other described species. Four species described by Furtos (1933) seem to be related to *C. suburbana,* at least superficially. However, it is impossible to ascertain from the descriptions given by Furtos that her species belong to the group Acuminata because that writer fails to give many of the characteristics necessary for assignment of particular species to the proper group. These possibly related species and the ways in which they differ from *C. suburbana* are as follows: (1) *C. suburbana* differs from *C. eriensis* Furtos 1933 in the undivided penultimate podomere of the third leg of the latter; the penis is wider; the shell has a conspicuous posterior-dorsal angulation and shows only six muscle scars. (2) *C. suburbana* differs from *C. scopulosa* Furtos 1933 in shell shape and in the unclear division of the penultimate podomere of the third thoracic leg in the latter form. The female genital lobe is much longer, the prehensile palps more curved, and the penis wider in *C. scopulosa.* (3) *C. decora* Furtos 1933 differs from *C. suburbana* in having the shell larger with a well angulated dorso-posterior margin. *C. decora* also has a much longer female genital lobe. (4) *C. distincta* Furtos 1933 differs from the new species by a well marked angulation and sinuation near the point where the posterior and dorsal margins of the shell meet. In a view from above, the fairly well rounded ends of the shell of *C. distincta* are in contradiction to the more pointed ends of *C. suburbana.* Other differences also occur. *C. suburbana* is also related to several species of Candona from Illinois. A comparison of these species with *C. suburbana* is given under the "remarks" in the description of *C. acuta* and needs not be repeated.

It is possible that *C. suburbana* may be the *C. elongata* described by Herrick (1879). Herrick's description is so incomplete and his figures so poor that it is impossible to make out with certainty just what species he actually collected. G. W. Müller (1912) through a gross error thought

that *C. caudata* Kaufmann 1900 was a synonym of *C. elongata* Herrick 1879 and took the name given by Herrick to be the valid name. Since then, Klie (1938a) and others have realized Müller's mistake and have rejected the name *C. elongata* Herrick. It is very obvious that *C. elongata* Herrick is not the same ostracod as *C. caudata* Kaufmann, as may be readily seen in a comparison of the shell of the two forms. While there is a remote possibility that *C. suburbana* and *C. elongata* might be the same, it is impossible to determine this with certainty on the basis of Herrick's inadequate description. In Herrick's figures (pl. 20, figs. 2, 2a, b, c) the shape of the shell, form of the antennae, and form of the prehensile palps indicate a Candona, but, at the same time, some of the setae are lacking from the third thoracic leg, the antennules have too few podomeres, and the ejaculatory duct is too much shortened for a Candona. If Herrick, who stated that he did not know whether the species is a Candona or a Cypris species, could not properly place the species in the genus and could not give figures which would make possible definite determination of the genus, certainly it is not safe to use his specific determination. To the present writer, it seems inadvisable to accept Herrick's name in view of the fact that his description and figures are so inadequate. If the type locality of *C. elongata* Herrick were known, it might be possible to secure topotypes and clear the situation, but the type locality is nowhere mentioned by Herrick.

Ecology: C. suburbana sp. nov. was taken from a temporary pond (ox-bow) which usually dries up at least by the serotinal season. The collections were made by dragging a plankton net in the grass along the edge of the pond where the water was from three to six inches deep. The water was clear and some algae were present.

Distribution: The writer has taken *C. suburbana* in only two collections from pond No. 2, Busey's Pasture, on the north outskirts of Urbana, Illinois. On May 22, 1940, eight mature males were taken and on June 9, 1940, a single mature female was obtained. Several previous and later collections from the same pond contained no individuals of this species.

The holotype (male) and the allotype (female) are deposited in the U. S. National Museum (Cat. Nos. 81073 and 81072). Paratypes (male) are in the collections of Dr. H. J. Van Cleave and the writer.

Candona fossulensis sp. nov.

(Pl. V, figs. 58-64)

Type Locality: Champaign County, Illinois.

Description of the female: A Candona of the Acuminata group. The shell has a height of more than one-half the length and is highest near the beginning of the posterior third. The left valve (fig. 58) has a slightly

convex dorsal margin with a weak sinuation at the junction of the dorsal and anterior margins. The anterior end is evenly and narrowly rounded. The posterior end is broadly rounded, appearing subtruncate and having the union of the dorsal and posterior margins marked by an angulation. The ventral margin is flatly concave with the concavity deepest near the center of the margin. The right valve is very similar in shape to the left with the exception that the sinuation between the dorsal and anterior margins is much more pronounced. The left valve is slightly larger than the right. The width of the shell is considerably less than the height. Measurements of the length and height of valves mounted in diaphane are as follows:

Right		Left	
Length	*Height*	*Length*	*Height*
0.99 mm.	0.52 mm.	1.00 mm.	0.54 mm. (holotype)
1.00	0.52	1.02	0.54
1.04	0.55	1.06	0.57

The shell margins exhibit many fine hairs especially at the anterior and posterior ends. Because of the proximity of the submarginal line and the valve margin, the pore-canals are obliterated except along the ventral margin in an area just anterior to the ventral sinuation. There is a rosette of five muscle scars with a single scar just above the rosette. This rosette is placed anterior to the center of the valve. A short distance ventral and anterior are two additional small, well-separated scars and some distance anterior and dorsal of the group are two more very small isolated scars. Posteriorly the shell has very peculiar markings (fig. 59) which divide the surface of the shell into irregular square and diamond-shaped areas. This sculpturing is conspicuous anterior to the posterior margin in an area which might be called the posterior slope. The markings cannot be observed in the anterior four-fifths of the shell.

The antennules and antennae are slender with the swimming setae of the former and the claws of the latter long and slender. The distal podomere of the antennules is nearly six times as long as wide; the fourth podomere is about as long as wide, and the more distal ones are all cylindrical. The terminal claws of the antennae reach to the level of the tips of the longest claws of the penultimate podomere. The penultimate podomere is well over twice as long as wide. The length of the sensory bristle of the antepenultimate podomere is less than the width of the podomere. The two distal podomeres of each mandibular palp (fig. 60) are more slender than in many Candona; the medial distal seta of the penultimate podomere is smooth, and the bundle on the antepenultimate podomere consists of four setae (fig. 60-S). The two terminal claws of the mandibular palp are short and heavy.

The second thoracic leg has the second podomere nearly equal in length to the sum of the lengths of the three distal podomeres and equal

in length to the distal claw of the appendage. The apparent penultimate and antepenultimate podomeres are equal in length; the length of the ultimate podomere is approximate to one-half the length of the penultimate. The ultimate podomere is longer than wide. The seta of the penultimate podomere is approximately three-fourths as long as the length of the podomere; the seta of the antepenultimate podomere is equal to the seta of the penultimate while the seta of the second podomere is usually slightly shorter. Considerable variation occurs in the relative lengths of the setae of the second leg. The basal podomere of the third thoracic leg (fig. 61) bears two setae. The penultimate podomere is divided; the ultimate podomere is as wide as long. The shortest distal seta is four times as long as the width of the ultimate podomere; the companion seta is a little less, and the oppositely directed seta a little more, than twice as long as the shortest distal seta.

The furca (fig. 62) is gently curved; the length of the ventral margin is nine times the least width of the ramus. The dorsal seta has a length equal to three or three and one-half or in some individuals nearly four times the least width of the furcal ramus. The dorsal seta is located a distance from the subterminal claw usually equal to a little more than three times the least width of the furca. The length of the terminal claw is a little less than one-half the dorsal margin of the furcal ramus. The length of the terminal seta is equal to the least width of the furcal ramus. The genital lobe (fig. 62) consists of a long finger-like projection attached to the dorsal-posterior margin of a large hemispherical base. The finger-like lobe has a concave, sometimes almost straight but never convex, dorsal edge and a convex ventral edge. The lobe is often distally bent dorsad.

Description of the Male: The shell of the male is similar to that of the female but slightly larger. The ventral sinuation of the shell of the male is more pronounced and somewhat anterior to the center of the ventral margin. Measurements of the valves of three males are as follows (mounted in diaphane):

Right		Left	
Length	*Height*	*Length*	*Height*
1.12 mm.	0.60 mm.	1.13 mm.	0.61 mm. (allotype)
1.18	0.62	1.20	0.64
1.17	0.59	1.19	0.—

The cephalic and thoracic appendages of the male resemble those of the female with the exception that the second thoracic legs are more slender.

The furca of the male is more slender than that of the female; the length of the ventral margin is from twelve to thirteen times the least width. Because of the slender condition of the distal end of the furcal

ramus, the dorsal seta has a length over four times the least width of the ramus and the length of the terminal seta is one and one-half times the least width of the ramus. The terminal claw has a length equal to about two-fifths of the dorsal margin of the ramus. The prehensile palps are dissimilar and somewhat unequal. The right (fig. 63a) is heavy and falciform; the left (fig. 63b) is less stout, and the tip extends straight without change in diameter for some distance distal of the bend of the palp. The penis (fig. 64) is wide and rather short; the middle and inner lobes are not well developed and do not extend beyond the penis proper; the outer lobe appears as a lappet with what appears to be a tubule ending at the margin a short distance dorsal to the tip of the lobe.

Remarks: Of all the described species of Candona, *C. decora* Furtos 1933 seems to be the most closely related to *C. fossulensis sp. nov.* That the two species are related is shown by the agreement of the two species in general shell shape and sculpturing and in the similarity of the penis and prehensile claws. The characteristics in which *C. fossulensis sp. nov.* and *C. decora* Furtos differ may be listed as follows:

	C. decora Furtos 1933	*C. fossulensis sp. nov.*
Female, size of shell	1.18-1.30 x 0.63-0.70	1.00-1.05 x 0.54-0.57
Male, size of shell	1.4-1.5 x 0.7-0.8	1.12-1.2 x 0.60-0.64
Dorsal-posterior angulation	More	Less
Female: 3rd leg, last podomere	Length more than width	Length equals width
Short seta, 3rd leg	3½ x last podomere	4 x last podomere
Furca, ventral margin	13 x least width	9 x least width
Furca, dorsal seta	⅞ of subterminal claw	5/7 or ⅘ of subterminal claw
Furca, dorsal seta	¼ from distal end of ramus	⅓ from distal end of ramus

A comparison of the characters of *C. fossulensis* with related Acuminata species from Illinois is given under *C. acuta* described herein.

Ecology: The type specimens were taken from a roadside ditch in which the water was three inches deep and the bottom was covered with dead grass. Another collection was made on the same date in a nearby vernal pond in which the water was up to twelve inches deep and there was little dead grass on the bottom.

Distribution: C. fossulensis sp. nov. has been taken in only two collections. These were from separate bodies of water in the same vicinity near Seymour, Champaign County, Illinois. The two collections were made on April 1, 1940.

The holotype (female) and allotype (male) of *C. fossulensis* are deposited in the U. S. National Museum (Cat. Nos. 81068 and 81069). Paratypes (female and male) are in the collections of Dr. H. J. Van Cleave, Dr. Arthur G. Humes, and the writer.

Candona acuta sp. nov.

(Pl. V, figs. 65-69; pl. VI, figs. 70-72)

Type Locality: Illinois.

Description of the Female: A Candona of the Acuminata group with the shell height and width approximating one-half of the shell length. The dorsal margin is flatly arched (fig. 65); the anterior end is narrowly and evenly rounded, a definite sinuation separating anterior and dorsal margins. The ventral margin has a very conspicuous sinuation slightly anterior to the mid-point, with the margin between the sinuation and the posterior-ventral angulation flattened. The posterior end has a bluntly rounded, subtruncate margin. The posterior and ventral margins join at nearly a right angle in the right valve. There is a very slight sinuation between the dorsal and posterior margins but this is more apparent than real as it is caused largely by the extension of the valve beyond the posterior shell margin. The ovary appears as a narrow band, posteriorly much more narrowed than in most Candona. The muscle scars consistently occur in a greater number than in many Candona as there is a nearly centrally located rosette of five loosely arranged scars, a single scar slightly more dorsad, two scars some distance anterior-ventrad, and two smaller scars anterior-dorsad of the rosette. The submarginal line is close to the margin of the valves so that the pore-canals are very short. The surface of the shell bears a few scattered hairs which are fairly conspicuous along the margins. From below (fig. 66), the sides of the shell form an even arc with the anterior slightly more pointed than the posterior.

The right valve of the holotype measures 1.07 mm. in length, 0.54 mm. in height, and 0.56 mm. in width. Measurements of the valves of other mature females (paratypes) are as follows (mounted in diaphane):

Right		Left	
Length	*Height*	*Length*	*Height*
1.06 mm.	0.53 mm.	1.10 mm.	0.56 mm.
1.05	0.54	1.09	0.56
1.08	0.55	1.13	0.58

The antennules show few characteristics helpful in specific diagnosis. The fifth, seventh, and eighth podomeres are equal in length; the sixth is slightly shorter. The antennae are short and stout; the terminal claws are very heavy and not proportionally as long as in many Candona. The longest claw of the penultimate podomere extends beyond the longest claw of the ultimate podomere. The penultimate podomere bears submedially a group of four small setae near the distal end of the podomere. The sensory organ of the antepenultimate podomere is much reduced, being

little more than one-half as long as the width of the podomere at the same level.

The medial-distal seta of the penultimate podomere of the mandibular palp is smooth; the bundle of setae on the antepenultimate podomere contains four setae. The second thoracic leg (fig. 67) has the length of the second podomere equal to the sum of the lengths of the distal three podomeres. The penultimate (fig. 67-P) is hardly as long as the antepenultimate podomere; the seta of the antepenultimate podomere reaches to the base of the seta of the penultimate and is not as long as the seta of the penultimate. The ultimate podomere is longer than wide and, besides the claw, bears a distal seta longer than the podomere and a subdistal seta equal to the length of the podomere. The terminal claw is usually a little longer than the sum of the lengths of the last three podomeres and is commonly recurved toward the distal end. The sides of the second, third, and fourth podomeres bear small spines.

The third thoracic leg (fig. 68) consists of five apparent podomeres through the division of the penultimate podomere (fig. 68-P). The basal podomere has two setae, both of which are long. The seta of the penultimate podomere is sometimes bent near the distal end and is very long; being approximate to the short seta of the ultimate podomere, it has a length equal to the sum of the length of the apparent antepenultimate and penultimate podomeres. There are a few very short spines along the sides of the penultimate podomere. The ultimate podomere is little longer than wide. The shortest of the three distal setae is nearly four times the length of the ultimate podomere; the companion seta is about twice as long as the shorter; the length of the oppositely directed seta is variable, either sub-equal or equal to the longer one of the pair and, like the shortest distal seta, is distinctly bent near the distal end.

The furcal ramus (fig. 69-R) is somewhat curved; the length of the ventral margin is ten times the least width. The dorsal seta (fig. 69-D) has a length of two and one-half times the least width of the ramus and is removed from the subterminal claw by a distance equal to a little less than one-third of the ventral margin. The length of the terminal seta is one and one-fourth times the least width of the furcal ramus. The claws are gently curved throughout their length; the length of the terminal claw is approximate to one-half of the length of the ventral margin of the furcal ramus. The claws are very finely toothed. The female genital lobe (fig. 69-G) is well developed, bluntly pointed at the posterior end, and separated from the thorax by a slight constriction. There is a seta (fig. 69-B) on the dorsal portion of the thorax near the base of the furca.

Description of the Male: The shell (fig. 70) of the male differs considerably from that of the female. The posterior end is broadly rounded,

COMPARISON OF SOME CLOSELY RELATED SPECIES OF THE ACUMINATA GROUP AS FOUND IN ILLINOIS

	C. caudata Kaufmann 1900	*C. sigmoides* Sharpe 1897	*C. indigena sp. nov.*	*C. suburbana sp. nov.*	*C. fossulensis sp. nov.*	*C. acuta sp. nov.*
Shell length	1.15-1.35 mm.	1.06 mm.	0.95-1.10 mm.	1.08 mm.*	1.00-1.06 mm.	1.10-1.13 mm.
Shell height	0.50-0.65 mm.	0.55 mm.	0.55-0.65 mm.	0.51mm.*	0.54-0.57 mm.	0.56-0.58 mm.
Junction of posterior and ventral margins	Angulation in left valve	Angulation in left valve	Wide angle	Rounded	Rounded	Angulation in right valve
Length of distal claw of second leg	Equals distal three podomeres	Equals distal three podomeres	Equals 1¼ times distal three podomeres	Less than sum of distal three podomeres	Nearly equals sum of distal three podomeres	Equals distal three podomeres
Furca:—						
Length of ventral margin	11 times least width of ramus	9-9½ times least width of ramus	9 times least width of ramus	11 times least width of ramus	9 times least width of ramus	9-10 times least width of ramus
Length of dorsal seta	2 times least width of ramus	3¼ times least width of ramus	3½ times least width of ramus	3½-4 times least width of ramus	3-3½ times least width of ramus	2½ times least width of ramus
Length of terminal seta	Same as least width of ramus	1-1⅓ times least width of ramus	1½ times least width of ramus	1½ times least width of ramus	Same as least width of ramus	1¼ times least width of ramus
Female genital lobe	Moderately long cone	Finger-like	Narrow, finger-like	Triangular	Hemispherical base; long projection	Separated from thorax by a constriction

*Measurements based on a single individual.

the anterior narrowly rounded. The dorsal margin is relatively uninterrupted and passes as an arc from the posterior to the anterior margins. The ventral margin is deeply sinuated, the sinuation being followed posteriorly by a flattened area along the ventral margin. In some shells, there is a slight angulation at the juncture of the posterior and dorsal margins and a slight sinuation at the beginning of the anterior margin. Measurements of the valves of several males (mounted in diaphane) are as follows:

Right		Left	
Length	*Height*	*Length*	*Height*
1.24 mm.	0.62 mm.	1.28 mm.	0.64 mm. (allotype)
1.19	0.59	1.22	0.62
1.26	0.64	1.31	0.69

The antennules and antennae are essentially like those of the female except for the presence of the male setae and the loss of the group of four small setae already mentioned. The second thoracic leg is like that of the female except in some males the entire appendage has a tendency to be slightly more slender with the terminal claw proportionally longer and often not recurved near the distal end. The third thoracic leg is similar to that of the female. In the furca, the ramus between the base of the dorsal seta and the subterminal claw is very narrow. This results in the length of the ventral margin being about fifteen times the least width of the ramus. The narrowed portion of the ramus is strongly curved. As a result of the narrowness of the furca, the dorsal seta has a length of about four and one-half times the least width and the terminal seta is nearly twice as long as the ramus is wide.

The prehensile palps are unequal and dissimilar. The left (fig. 71a) has a very long, straight, and narrowed distal portion; the right (fig. 71b) is falciform, shorter, and stouter than the left. Considerable variation is shown in the prehensile palps, especially in the left where the degree of relative narrowness and length is often different from that shown in the pictured paratype. The penis (fig. 72) is elongated, the outer lobe (fig. 72-O) well developed and the other two lobes small and poorly developed.

Remarks: A tabular comparison of *C. acuta* with closely related species of the Acuminata group as found in Illinois is given herewith. (The chart compares females only.)

Ecology: Most collections of *C. acuta sp. nov.* have been made in grass and decaying vegetation along the edges of small streams, usually temporary, three to eight feet wide, and up to two feet deep, where the water is clear and cool and there is considerable current. In one instance, the species was taken from a pond connected to a small stream only during high water stages and, in another instance, from the stomach of a fish,

Catostomus commersonii, from the stripland ponds near Oakwood, Illinois. The species seems not to be restricted to any season, having been taken in May, July, and November.

Distribution: C. acuta sp. nov. has been taken from Champaign County, Livingston County, and Vermilion County, Illinois. The species seems to be restricted to the cooler waters of the state and has not been collected from the southern part of the state. It has not been reported outside of Illinois.

The holotype (female), allotype (male), and two paratypes (one female, one male) are deposited in the U. S. National Museum (Cat. Nos. 81074, 81075, 81076, and 81077). Other paratypes (both female and male) are in the collections of Dr. H. J. Van Cleave, Dr. Arthur G. Humes, and the writer.

Group Fabaeformis

The group of setae on the antepenultimate podomere of the mandibular palp consists of three or five setae. Characters otherwise as in the group Acuminata.

Upon the basis of present information, it is impossible to assign any Illinois species definitely to the group Fabaeformis. *C. sharpei sp. nov.* may belong here, especially as this species was formerly assigned to the European species *C. fabaeformis* Fischer 1851 by Sharpe (1897, 1918). However, the inadequate available description seems to point to the placement of this species in the group Acuminata. As a result, *C. sharpei sp. nov.* has been tentatively assigned to the group Acuminata but may be reassigned when more details of its structure become known.

SUBFAMILY CYCLOCYPRINAE

Shell usually short and high, more or less rounded (figs. 76, 98). Swimming setae of the antennae well developed (fig. 76-A) but occasionally reduced; usually twice as long as the distance from their origin to the tips of the terminal claws of the antennae. Antenna in female of five, in male of six podomeres through a division of the penultimate podomere. The first thoracic leg with well developed respiratory plate; the palp (endopodite) in the female consists of one or two podomeres; in the male it is modified as a grasping palp or prehensile palp of two podomeres (fig. 80). The distal podomere of each palp forms a movable finger called the dactylus (fig. 80a-D) and rests on the proximal podomere which is designated as the propodus (fig. 80b-P). Third thoracic leg with three distal setae (figs. 84, 91), of which one is long and reflexed, the other two are much shorter and not reflexed in most species. Ductus

ejaculatorius (fig. 93) with the proximal extremity of the tubule forming a dilated pouch, the distal end forming a funnel-shaped sac leading into the vas deferens.

The subfamily Cyclocyprinae replaces as a taxonomic unit the subfamily Cyclocypridinae used by Sharpe (1903, 1918). Many writers, as Furtos (1933), prefer to group the genera belonging to the Candoninae and Cyclocyprinae into the subfamily Candocyprinae, which is then subdivided into *tribes* of less than subfamily and more than generic importance. The tribe Cyclocyprini is used by Furtos (1933, 1935) as an equivalent to the subfamily Cyclocyprinae as used herein. To the present writer, it seems desirable to avoid the use of such subdivisions as tribes which tend to complicate the system of classification without introducing any real advantage not gained by a simpler system.

As found in Illinois, the subfamily Cyclocyprinae includes three genera: Cyclocypris Brady and Norman 1889, Cypria Zenker 1854, and Physocypria Vávra 1897. A fourth American genus, Candocypria Furtos 1933, is found in Ohio but has not been discovered in Illinois.

KEY TO GENERA OF THE SUBFAMILY CYCLOCYPRINAE IN ILLINOIS

1a. Shell tumid; the last podomere of the third thoracic leg at least twice as long as wide (fig. 75).....Genus Cyclocypris Brady and Norman 1889

b. Shell compressed; the last podomere of the third thoracic leg not much longer than wide (figs. 84, 89).....2

2a. Valves nearly equal, margin of both valves smooth (fig. 76).....Genus Cypria Zenker 1854

b. Valves commonly unequal in height or length or both; margin of either right or left valve more or less tuberculated (fig. 98).....Genus Physocypria Vávra 1897

Genus CYCLOCYPRIS Brady and Norman 1889

Shell rounded, height and width greater than one-half the length (fig. 73); surface of shell smooth, brown in color. Eye well developed. Swimming setae of both antennules and antennae are long and well adapted for swimming. The penultimate podomere of the second antenna in the male is divided, but no specialized male setae are present. Respiratory plate of the first thoracic leg with six plumose setae. Third thoracic leg consisting of four podomeres (fig. 75); the ultimate podomere elongated, more than twice as long as wide and usually at least one-half as long as the penultimate podomere. Ultimate podomere of third leg with three distal setae, unequal, with the outermost one very long and reflexed. The dorsal setae of the furca often greatly reduced and usually removed some distance from the subterminal claw.

KEY TO SPECIES OF THE GENUS CYCLOCYPRIS IN ILLINOIS

1a. Shell less than 0.5 mm. in length; terminal seta of the furca at least three-fourths as long as the terminal claw; dorsal seta of furcal ramus absent or rudimentary.....*C. sharpei* Furtos 1933

b. Shell over 0.5 mm. in length; terminal seta of furca not over one-half as long as the terminal claw; dorsal seta of furcal ramus present.....*C. forbesi* Sharpe 1897

Cyclocypris forbesi Sharpe 1897

(Pl. VI, figs. 73-75)

Cyclocypris forbesi Sharpe 1897. Sharpe, 1897:432-433, pl. 41, figs. 1-7; 1918:822, figs. 1290a, b, c, d, e, f; Furtos, 1935:535-537, fig. 3.

Type Locality: McLean County, Illinois.

Description of the Female: An ostracod of the genus Cyclocypris. According to Sharpe (1897), the shell measures 0.55 mm. in length, 0.39 mm. in height, and 0.36 mm. in width. The single female individual observed in the present writer's collection was slightly larger, measuring 0.62 mm. in length and 0.47 mm. in height. The shell (fig. 73) is plump with the right valve slightly larger than the left. The height is almost equal to three-fourths of the length. The color of the shell is a sepia brown and there are occasional hairs especially along the margins. The shell is subelliptical with the dorsal margin arched. The posterior margin is more broadly rounded than the anterior margin.

The ultimate podomere of the antenna is about as long as wide, the penultimate is about four times as long as the ultimate, and the antepenultimate is more than one and one-half the length of the penultimate. The sensory organ of the antepenultimate podomere is extremely long, reaching past the distal end of the podomere to which it is attached. The terminal claws are curved near the tip, beyond which the swimming setae reach a distance equal to three times the length of the terminal claws.

The curved terminal claw of the second thoracic leg (fig. 74) has a length equal to more than the sum of the distal three podomeres of the leg. The third thoracic leg (fig. 75) has the "terminal segment . . . . three fifths as long as the preceding segment. The longer of the backwardly directed setae is longer than the combined lengths of the last three segments, the shorter one being one fourth as long, or the length of the last segment; terminal claw half as long as the last segment" (Sharpe, 1897). The furca is somewhat bent, the terminal claw is about one-half as long as the ventral margin of the ramus, and the subterminal claw is four-fifths as long as the terminal. Both claws are strongly bent at the tip. "Terminal seta about as long as width of the ramus; dorsal seta delicate, two and a half times width of ramus from subterminal claw, and two thirds as long as ramus is wide" (Sharpe, 1897).

Description of the Male: The male is very adequately described by Furtos (1935). It is much the same in general shape and size as the female. The prehensile palps are unequal and elongated; "ejaculatory duct quite small, with crowns of spines surrounding openings easily visible, the others quite obscure. Penis roughly quadrangular with a beak-like terminal lobe" (Furtos, 1935). The male was not observed by the present writer.

Remarks: Sharpe seems to have made a mistake in regard to the setae of the penultimate podomere of the third thoracic leg when he states: "Penultimate podomere three and a half times as long as broad and armed on the inner edge with but one seta, which is on the middle of the segment, and half its length"(Sharpe, 1897). In the individual observed by the present writer there is a seta in the middle and another at the distal end of the podomere as is usual in the genus Cyclocypris. Furtos (1935) pictures two setae of nearly equal length on the penultimate podomere. It is entirely possible that Sharpe examined some damaged individuals. The present writer has often found, especially in the Cyclocyprinae, that the distal seta of the penultimate podomere of the third thoracic leg may easily become broken.

Ecology: The type specimens were collected from a woodland pond near Bloomington, Illinois, on April 5, 1879 (Sharpe, 1897). Furtos (1935) took her material from a pond, details of which are not given. The present writer found a single female in a collection made from mats of vegetation (Chara, Myriophyllum, and Potamogeton) from a lake in northeastern Illinois.

Distribution: This species has been reported from McLean County, Illinois, by Sharpe (1897) and from Falmouth, Cape Cod, Massachusetts, by Furtos (1935). The writer has it in a single collection from Illinois. This collection, made by Mr. Bert Wright, was from East Loon Lake, near Antioch, Lake County, Illinois, on August 7, 1940.

Cyclocypris sharpei Furtos 1933

Cyclocypris laevis Sharpe 1908 (*non* O. F. Müller 1785). Sharpe, 1908:408-410, pl. 50, fig. 5, pl. 54, figs. 5-7.

Cyclocypris laevis Sharpe 1918 (*non* O. F. Müller 1785). Sharpe, 1918:822, fig. 1289a, b, c.

Cyclocypris sharpei Furtos 1933. Furtos, 1933:460-461, pl. 14, figs. 8-14.

Type Locality: Ohio.

Description of the Female (after Furtos, 1933): A Cyclocypris species measuring 0.47 mm. in length, 0.33 mm. in height, and 0.33 mm. in width. Extremities of shell broadly rounded, posterior somewhat broader; ventral

margin slightly convex. The left valve is the larger. Color chestnut-brown. Ultimate podomere of third leg one-half as long as the penultimate, three times longer than broad. Shortest distal seta one-third as long as the podomere and often S-shaped. Furcal ramus slightly curved; dorsal seta usually absent, sometimes rudimentary; terminal claw one-third as long as the ramus; the terminal seta at least three-fourths the length of the terminal claw.

Description of the Male (condensed from Furtos, 1933): Similar to female; length 0.46 mm., height 0.32 mm., breadth 0.32 mm. Prehensile palps short and unequal; penis roughly globose, with one narrow and one broad terminal lobe.

Remarks: While it is probable that the true *C. laevis* of O. F. Müller does occur in the United States (Turner, 1895), Sharpe (1908) certainly did not have that species. It seems strange that he did not realize the differences which occur between his form (now called *C. sharpei*) and the true *C. laevis* of O. F. Müller.

Ecology: Sharpe (1908) reported this species under the designation *C. laevis* from ponds and swamps southeast of Chicago, Illinois. Furtos (1933) reports *C. sharpei* as being "common in ponds, marshes and lakes." There seems to be no seasonal restriction except that collections so far have not been reported from the haemal season.

Distribution: The species was reported from Illinois (southeast of Chicago), Indiana, and New York by Sharpe (1908) and from New Jersey (Sharpe, 1918). Furtos (1933) reports it from several places in Ohio. The present writer has not found individuals of this species in any of his collections from Illinois.

Genus CYPRIA Zenker 1854

Shell usually short, high (fig. 76), occasionally elongate reniform (fig. 82); strongly compressed; margins smooth, not tuberculate. Eyes well developed. Second antenna of the male with the penultimate podomere divided and bearing specialized male setae. The ultimate podomere of the mandibular palp elongated, often as much as three times as long as the proximal width. Palp of the maxilla well developed, masticatory processes weak. Penultimate podomere of the third thoracic leg undivided (fig. 84); ultimate podomere short (fig. 89), scarcely longer than wide; the longest distal seta is reflexed, the two unreflexed setae equal or unequal and usually not much longer than the length of the ultimate podomere (figs. 84, 89, 91). Terminal and subterminal claws of the furca strong, dorsal seta may be rudimentary (figs. 79, 92). Ductus ejaculatorius with seven whorls of chitinous rays and the proximal end of the duct much inflated (fig. 93). Penis with two terminal lobes only; outer

lobe wanting (fig. 95). In most species, the females are more numerous than the males.

The genus Cypris is attributed to Zenker (Zenker, 1854) who used the name "Cypria" in a subgeneric sense. However, he gave no diagnosis but described five species in the subgenus. The first available description of the genus Cypria appears to be that given by Brady and Norman (1889). In order to place *C. mediana sp. nov.* in the genus Cypria, it has been necessary to revert to the original diagnosis of Brady and Norman (1889) rather than the descriptions of later writers who have restricted the genus in various ways. The principal difficulty in fitting *C. mediana sp. nov.* into the genus Cypria as diagnosed by recent authors is the condition of the setae of the third thoracic leg. According to Furtos (1933) the third leg is armed distally "with two short and one long setae, the latter reflexed." Klie (1938a) restricts the genus Cypria still more in this respect when he writes "Vorletztes Gl. des Putzfusses ungeteilt, Endgl. kurz, seine lange Borste zurückgekrümmt, die beiden vorwärts gerichteten nicht auffalend verschieden und kaum länger als das zugehörige Glied." In *C. mediana sp. nov.* the shorter of the two unreflexed distal setae of the third leg (fig. 84) has a length equal to one and one-half to two times the length of the ultimate podomere and the longer of the pair is twice the length of the shorter. Brady and Norman (1889) place no restriction upon the relative lengths of the distal setae of the third thoracic leg in the genus Cypria.

KEY TO SPECIES OF THE GENUS CYPRIA IN ILLINOIS

1a. Surface of shell marked with closely set parallel and anastomosing longitudinal lines (fig. 78) ..... *C. turneri sp. nov.*

b. Surface of shell not so marked 2

2a. Shell over 0.70 mm. long; length of the shorter terminal seta of the similarly directed pair on the third leg equal to one-half of the longer of the pair (fig. 89) 3

b. Shell less than 0.70 mm. long; length of the shorter of the pair of similarly directed setae of the third leg more than one-half the length of the longer (fig. 91); color bands, blotches, or patches present on shell 4

3a. The length of the terminal claw of the furca almost as long as the ventral margin of the furca (fig. 85); shell elongate with conspicuous concavity in the ventral margin (fig. 86) ..... *C. mediana sp. nov.*

b. The length of the terminal claws of the furca little more than three-fifths of the ventral margin of the ramus; shell suboval with almost straight ventral margin (fig. 88) ..... *C. obesa* Sharpe 1897

4a. Three color blotches; one anterior, one posterior, and one behind the eye (fig. 90); length of dorsal seta of furca about equal to the width of the ramus; subterminal claw of ramus heavily toothed (fig. 92) .. *C. maculata sp. nov.*

b. Small specks of pigment arranged in small patches and scattered over most of the shell surface (fig. 96); dorsal seta of furca has a length about twice the least width of the ramus; claws of the furcal rami lightly toothed ..... *C. ophthalmica* (Jurine 1820) Brady and Norman 1889

Cypria turneri sp. nov.

(Pl. VI, figs. 76-81)

Cypria striolata Herrick 1887 (*non* Brady 1864, synonym of *C. exsculpta* (S. Fischer 1855)). Herrick, 1887:29, pl. 4, fig. 3.

Cypria exculpta Turner 1894 (*non C. exsculpta* (S. Fischer 1855)). Turner, 1894: 13-14, pl. 7, figs. 2-8; 1895:305, pl. 70, figs. 1-8; pl. 72, fig. 3.

Cypria exsculpta Sharpe 1897 (*non* S. Fischer 1855). Sharpe, 1897:465-466, pl. 47, fig. 4; Kofoid, 1908:258; Shelford, 1913:152; Sharpe, 1918:820, figs. 1283a, b, c, d.

Cypria elegantula Furtos 1933 (*non* Lilljeborg 1853). Furtos, 1933:465-466, pl. 15, figs. 8-14; Dobbin, 1941:237, pl. 9, figs. 13-21, pl. 10, figs. 1-2.

Type Locality: Illinois.

Description of the Female: An ostracod of the genus Cypria. From the side, the shell (fig. 76) is subovate; height equal to a little less than two-thirds of the length; highest in or very near the middle. The dorsal margin is strongly arched with a slight flattening anteriorly above the eye; the anterior and posterior ends are rounded, the anterior end slightly more narrow than the posterior end. The ventral margin is usually, but not always, slightly concave. A thin hyaline border is present in both valves, especially along the anterior and posterior margins. From below (fig. 77), the shell appears compressed; the greatest width is near the center and is slightly less than one-half the length of the shell; the anterior end is pointed and the posterior end is rounded. The left valve is slightly the larger. The surface of the shell is marked with peculiar parallel, frequently anastomosing longitudinal lines (fig. 78) which form a network over the entire surface of both valves. The color of the valves is yellow and there are occasionally some light brown markings varying greatly in intensity and extent. These are usually not as conspicuous, however, as they are in many species of the genus Cypria, being light in color and often confined to narrow areas along the anterior and posterior margins of the valves. There are a few scattered hairs along the margins. Measurements of valves of several mature females from Illinois are as follows:

Right		Left	
Length	*Height*	*Length*	*Height*
0.54 mm.	0.35 mm.	0.55 mm.	0.35 mm. (holotype)
0.55	0.35	0.56	0.36
0.61	0.38	0.61	0.39
0.56	0.34	0.57	0.35

The length of the sensory organ of the antennae equals in length the width of the podomere to which the organ is attached, the width of the podomere being taken at the level of the base of the sensory organ; the organ reaches to the level of the distal margin of its podomere. Swimming setae of the antennae are variable in length, often reaching beyond

the tips of the terminal claws for a distance about equal to three times the length of the longest terminal claw. The terminal claw of the second thoracic leg has a length equal to the sum of the lengths of the antepenultimate and penultimate podomeres. These two podomeres are equal in length. The terminal podomere of the third thoracic leg has a length equal to about one and one-half times the width; the two distal setae of the pair are slightly unequal, one having a length nearly equal to the length of the podomere, the other slightly longer. The terminal seta of the penultimate podomere of the third thoracic leg is wanting while the lateral seta arises from the basal one-third of the podomere. The penultimate podomere is nearly four times the length of the ultimate podomere. The seta of the antepenultimate podomere reaches scarcely to the base of the lateral seta of the next distal podomere, being much shorter than in many Cypria species.

The furca is curved and stout. The ventral margin is seven to seven and one-half times the least width of the ramus. The size of the furcal ramus as given by Furtos (1933) for *C. elegantula* from Ohio is eleven times the narrowest width. This is evidently an error as the furca which she pictures (her pl. 15, fig. 11) has a length-width ratio compatible to that found by the present writer. The dorsal seta of the furcal ramus has a length equal to nearly two times the least width of the ramus or to about one-half the length of the subterminal claw. The dorsal seta is removed from the subterminal claw by a distance equal to two and one-half times the least width of the ramus or one-third of the dorsal margin. The terminal seta has a length about one and one-half times the least width of the furcal ramus. The terminal claw has a length approximately equal to one-half of the dorsal margin of the ramus and the subterminal claw has a length between four-fifths and five-sixths the length of the terminal one. Both claws are curved and nearly smooth. The few distal teeth are so fine that they cannot be seen in well cleared individuals but may be detected in material mounted in glycerine.

Description of the Male: The shell of the male is similar to that of the female but slightly smaller. The allotype measures 0.54 mm. in length and 0.34 mm. in height and is representative of the average size. The furca (fig. 79) has the same proportions as the furca of the female but is more curved. The other appendages are essentially like the corresponding ones of the female. The prehensile palps are dissimilar and unequal. The propodus of the left palp (fig. 80a) is over four times as long as wide and the sides are rather straight and parallel; the dactylus is very slender and falciform, being distally recurved. The propodus of the right palp (fig. 80b) is stouter and shorter than that of the left palp. The peculiar ventral-distal process of the propodus of the right palp is shown

in the figure. The dactylus of the right palp is large and highly curved. It is considerably inflated proximally but tapers to an elongated slender distal portion. The penis (fig. 81) is peculiar, being not exactly as shown by Furtos (1933:pl. 15, fig. 14) for *C. elegantula* of Ohio. In the present writer's material, the penis has two lobes each of which has a slender tip. The inner lobe is proximally widened and flap-like but, unlike the other indigenous Cyclocyprinae, it is suddenly constricted to a narrow, recurved distal point. The middle lobe reaches nearly to the distal end of the inner lobe. It is slender and gently curved throughout the distal one-half. Usually only a small percentage of the individuals in any collection consists of male animals, the females exceeding the males in abundance.

Remarks: Individuals of *C. turneri sp. nov.* have long been assigned to the European species *C. exsculpta* (S. Fischer 1855) Brady and Norman 1889. Furtos (1933) assigned individuals which apparently are *C. turneri sp. nov.* to *C. elegantula* Lilljeborg 1853 although the latter is a synonym of *C. exsculpta* (S. Fischer 1855). Although "elegantula" is an older specific name than "exsculpta," it is invalid because the name "elegantula" was used by S. Fischer in 1851 for individuals now known to belong to the species *C. ophthalmica* (Jurine 1820). Although *C. elegantula* (Fischer 1851) has become a synonym of *C. ophthalmica* (Jurine 1820), *C. elegantula* cannot be used in place of *C. exsculpta* (S. Fischer 1855). *C. exsculpta* (S. Fischer 1855) is then the valid designation of the European species into which many writers have placed individuals belonging to a closely related American species which is described herein as *C. turneri sp. nov.*

The correctness of assigning this American Cypria species, which is characterized by parallel longitudinal lines on the shell, to the European species *C. exsculpta* has been questioned by several writers. G. W. Müller (1912) questioned Turner's identification of the American form and did not even mention the form listed by Sharpe under the European name. Furtos (1933) states "There is a possibility that the Ohio species should not be referred to *elegantula* of Europe." She supported her contention by noting the difference in size of the shell, the difference in the penis, and the "smooth furcal claws" of the European species. Regarding the last item, Furtos was incorrect as the claws of the individuals of *C. exsculpta* of central Europe are toothed according to Kaufmann (1900a) who says that the furca "tragt am Ende zwei schmale, gezähnelte Klauen."

After a study of many complete descriptions of the *Cypria exsculpta* indigenous to Europe and after examining a large series of *C. turneri* from Illinois, the writer has found the following substantial differences

between the true *C. exsculpta* of S. Fischer and the American species now designated as *C. turneri sp. nov.*

	C. exsculpta (S. Fischer)	*C. turneri sp. nov.*
Shell length, female	Over 0.70 mm.	Under 0.65 mm.
Shell height/length ratio	Over 70%	Under 65%
Ventral margin of shell	Convex	Straight or concave
Third thoracic leg	Seta of penultimate podomere near center; ultimate podomere elongated	Same near basal one-third of podomere; ultimate podomere relatively short
Penis	Oval; inner lobe not distally recurved hook-like	Elongate; inner lobe hook-like distally
Prehensile palps	Propodus of right and left palps equal	Propodus of left palp longer than that of right
Ductus ejaculatorius	Oval	Elliptical; elongate

Because there are fixed differences and there appears to be no transition between the European *C. exsculpta* and the American *C. turneri,* they are certainly separate and distinct morphological species. The use of the characteristic longitudinal lines as the main taxonomic criterion for the recognition of the species *C. exsculpta* without checking any of the other structures probably led to the early, easily perpetuated error in designation. The specific name, "turneri," suggested for this new species is in memory of C. H. Turner, one of the outstanding early workers on American Entomostraca.

Ecology: C. turneri sp. nov. is found only in ponds and lakes, never in running waters except in backwaters of rivers or quiet pools of small, usually vernal streams. It is very abundant in temporary ponds. Under the name *C. exsculpta,* Shelford (1913) reports this species as common in ponds of the Chicago region. Sharpe (1897) writes that this species is common in most "running streams" but the present writer with few exceptions has not found this species in streams. It is often found associated with algae, water plants, and grass but may be found in open water as an occasional constituent of plankton. This species is very abundant from March to late June but is sometimes found in the serotinal and autumnal seasons.

Distribution: This species has been reported under the name *C. exculpta* or *C. exsculpta* from Alabama (Herrick, 1887), from Ohio, Georgia, and Delaware by Turner (1894), from Maine by Procter (1933), and from Illinois by Sharpe (1897), Kofoid (1908), and Shelford (1913). The *Cypria exsculpta* mentioned by Creaser (1931) as occurring in crayfish burrows in Missouri is probably also this species. Under *C. elegantula,* this species has been reported from Ohio by Furtos

(1933) and from Washington and Alaska by Dobbin (1941). Since it has been long confused with the European species *C. exsculpta* (S. Fischer 1855), it is impossible to determine its range. *C. turneri sp. nov.* is probably confined, however, to the Nearctic region. The present writer has taken it in collections from counties in many parts of the state of Illinois.

The holotype (female), allotype (male), and a paratype (female) are deposited in the U. S. National Museum (Cat. Nos. 81078, 81079, and 81080). Paratypes (male and female) are in the collections of Dr. H. J. Van Cleave, Dr. Arthur G. Humes, and the writer.

Cypria mediana sp. nov.

(Pl. VI, figs. 82-87)

Type Locality: Illinois.

Description of the Female: A species of the genus Cypria. Shell (fig. 82) elongate; height equal to little more than one-half the length, greatest near the center or somewhat anterior to the center. The left valve is slightly larger than the right. The dorsal margin forms a low arch, blending without interruption into the anterior and posterior margins except for a very weak sinuation which, especially in the right valve, may occur near the anterior end. The anterior and posterior ends are evenly rounded; the posterior is more narrow than the anterior. The ventral margin is concave, the concavity being deepest in the center of the posterior two-thirds of the shell. Pore-canals are present only along the ventral margin of the left valve. A hyaline border is found along the ventral, posterior, and anterior margins of each of the valves. The muscle scars are nearly centrally placed; six scars, five of which are large and one of which is inconspicuous, are found arranged in a loose group; a small isolated scar is located dorsal-anteriorly of the group while a pair of long scars are found anterior and slightly ventral of the group. A few hairs are evident along the anterior margin of the shell. Flakes of pigment may occur on the anterior and posterior slopes of the valves. The valves of three mature females from Illinois (mounted in diaphane) measure as follows:

Right		Left	
Length	*Height*	*Length*	*Height*
0.94 mm.	0.50 mm.	0.— mm.	0.52 mm. (holotype)
0.90	0.54	0.91	0.58
0.88	0.48	0.90	0.49

Shell from below (fig. 83): compressed, pointed posteriorly and anteriorly; greatest width in the anterior one-half of the shell and approximately equal to two-fifths of the length.

Each antenna consists of five podomeres; the sensory organ has a length slightly less than the distal width of the third podomere. The swimming setae of the antennae extend beyond the tips of the terminal claws for a distance little longer than the length of the claws. The terminal claws and the claws of the penultimate podomere are very long and slender; the claws of the penultimate podomere reach distally beyond those of the ultimate podomere. The ultimate podomere of the mandibular palp is nearly twice as long as the width at the base; the distal claws are of greatly varying lengths, the longest at least twice the length of the ultimate podomere. The processes of each maxilla are short; the palp is of two podomeres and has the short terminal podomere distally widened, with three nearly equal spine-like setae and several smaller ones.

The second thoracic leg with the antepenultimate and penultimate podomeres equal; the ultimate podomere small, about as long as the basal width. The distal claw of the second leg is approximately equal to one and one-half times the combined lengths of the distal three podomeres. Of the two terminal setae approximate to the distal claw, one is approximately as long as the penultimate podomere, the other two-thirds as long. The third thoracic leg (fig. 84) has the antepenultimate and penultimate podomeres nearly equal in length. The ultimate podomere is but little longer than wide. Of the two unreflexed distal setae, the shorter is one and one-half to two times the length of the ultimate podomere, and the longer is twice the shorter. The distal seta of the penultimate podomere is reduced to a short spine and is surrounded by a crown of fine bristles; the lateral seta of the penultimate podomere is attached near the anterior end of the basal half of the podomere and reaches beyond the distal end of the podomere. The distal seta of the antepenultimate podomere measures between one-half and two-thirds the length of the podomere and reaches at least to the base of the lateral seta of the penultimate podomere. Lateral hairs are present along the sides of the antepenultimate and penultimate podomeres.

The ventral margin of the furca (fig. 85) is slightly curved and measures less than seven times the least width. Dorsal seta but little longer than the least width of the ramus and removed from the subterminal claw by a distance equal to a little more than twice the least width of the ramus, or about one-third of the length of the ventral margin of the ramus. The terminal claw is almost as long as the ventral margin of the ramus; the subterminal claw is four-fifths as long as the terminal. The terminal seta is equal in length to one-third of the terminal claw. Both claws are so finely toothed that superficially they appear smooth.

Description of the Male: Shell in general appearance like the female but smaller. The right valve (fig. 86) of the allotype (mounted in dia-

phane) measures 0.82 mm. in length and 0.44 mm. in height; the left valve measures slightly more. The testes are much larger than in most species of the genus Cypria. In the right valve, there is a slight sinuation at both ends of the dorsal margin. The appendages are similar to those of the female except the claw of the second leg is relatively longer. The prehensile claws and ductus ejaculatorius are Cypria-like and offer no special details. The penis (fig. 87) has a rather wide, flap-like, and blunt inner lobe and a narrow, chitinized middle lobe with a curved tip.

Remarks: C. mediana sp. nov. with the exception of two or three details of structure fits into the genus Cypria as usually diagnosed. The shell is more elongate than is usual in individuals of the genus and the two distal setae belonging to the pair on the ultimate podomere of the third leg are more unequal in length, resembling a Candona species in this respect. However, the nature of the setae of the penultimate podomere of the third leg is typically that of a Cypria species. The male sexual organs are those of the subfamily Cyclocyprinae. The placing of this species in the genus Cypria has made necessary certain relatively unimportant emendations to the genus. These have been discussed under the diagnosis of the genus.

Ecology: Of the three collections made by the writer containing *C. mediana sp. nov.,* one came from a grass covered area in an ox-bow, one from water plants in a pool of a dried up stream, and the third from water plants and old leaves along the edge of a sluggish vernal stream. Individuals of this species seem to tolerate an acid environment. All of the individuals taken were mature and were taken in the first ten days of June, 1940.

Distribution: This species is known only from southern Illinois, having been taken by the writer in a single collection from Johnson County, one from Marion County, and a third from Massac County, Illinois. The writer has not found this species in the northern one-half of the state.

The holotype (female) and allotype (male) of this species are deposited in the U.S. National Museum (Cat. Nos. 81081 and 81082). One paratype (female) is in the collection of Dr. H. J. Van Cleave and paratypes of both sexes are retained in the writer's collection.

Cypria obesa Sharpe 1897

(Pl. VII, figs. 88-89)

Cypria obesa Sharpe 1897. Sharpe, 1897:462-463, pl. 48, figs. 1-5; 1918:821, figs. 1285a, b, c, d; Furtos, 1933:466-467, pl. 15, figs. 1-7.

Type Locality: Havana, Mason County, Illinois.

Description of the Female: A Cypria species. Shell (fig. 88) brownish in color, plump; suboval with nearly straight ventral margin. Height

about three-fifths of the length. Length varies from 0.74 to 0.86 mm., height from 0.44 mm. to 0.52 mm. The sensory organ on the inner edge of the third podomere of the antenna short; natatory setae extend beyond the tips of the terminal claws by twice the length of the claws. Last podomere of the third thoracic leg (fig. 89) slightly longer than wide; shortest distal seta equal to the length of the ultimate podomere; the longer of the pair twice the shorter. The distal seta of the penultimate podomere of the third leg much reduced and surrounded by a crown of fine bristles. Furca with terminal claw three-fifths as long as the ramus. Terminal seta about one and one-half times the least width of the ramus and the dorsal seta about as long as the width of the ramus. The dorsal seta is located a distance of three times the least width of the ramus from the subterminal claw.

Description of the Male: Slightly smaller than the female, otherwise similar. Prehensile palps dissimilar and unequal. Penis triangular with two subequal terminal lobes.

Remarks: The writer's specimens are identical with those described by Sharpe with the exception that the furcal ramus has a smooth dorsal margin instead of the toothed margin as described by Sharpe (1897). Furtos (1933) also noticed this incompatibility between her specimens and the description of Sharpe.

Ecology: Sharpe (1897) took this species from the sandy shore of a lake in central Illinois and Furtos (1933) reports it from a stone-quarry pool and a cold spring in Ohio. The present writer has found it as a rule associated with submerged grasses and water plants in shallow water, more often than not over a mud bottom. In fact, in seven out of eight places where this species was collected, there was an abundance of vegetation, as is common along the edges of river backwaters, swamps, and temporary vernal pools. In one instance, this species was taken from a muddy pool where there was no vegetation but as this pool was a remnant of a much larger one, it is entirely possible that this form was merely a survivant. All of the collections containing this species were made in quiet waters except that one collection was made from weeds and old leaves in a small stream not over five feet wide and having a very slow current and another was from the edge of Rock River where there was little current. This species seems to be characteristic of the aestival season rather than the vernal as is common with many Cypria species.

Distribution: This species has been previously reported from Havana, Mason County, Illinois, by Sharpe (1897); from Jackson Park, Chicago, Illinois, by Sharpe (1910); and from Newark and Granville, Ohio, by Furtos (1933). The present writer has collected *C. obesa* from six counties in Illinois. With the exception of Massac County which is at

the southern tip of the state, all of the Illinois reports for this species are from the northern one-half of the state.

Cypria maculata sp. nov.

(Pl. VII, figs. 90-95)

Cypria opthalmica (at least in part) Turner 1895 (*non C. ophthalmica* (Jurine 1820)). Turner, 1895:306, pl. 75, figs. 1-3, 7; pl. 76, figs. 1-3, 5.

Cypria ophthalmica Sharpe 1897 (*non* Jurine 1820). Sharpe, 1897:466-468, pl. 47, fig. 5; Kofoid, 1908:258.

Cypria ophthalmica (at least in part) Sharpe 1918 (*non* Jurine 1820). Sharpe, 1918:821, figs. 1284a, b, c, d.

Type Locality: Illinois.

Description of the Female: A species belonging to the genus Cypria. Shell (fig. 90) from the side reniform; the dorsal margin forming a high arch slightly flattened anteriorly where it passes into the anterior margin near the eye. The anterior and posterior margins rounded, the posterior more broadly so. The ventral margin is nearly straight. The pore-canals are very short as a result of the proximity of the submargin and margin; the hyaline border of the valves common to many species of Cypria is absent. The muscle scars are nearly centrally located. From above, the shell appears compressed, greatest width less than the greatest height but more than one-half of the length of the shell; "widest at the posterior third, narrow, somewhat acutely pointed anteriorly and rounded posteriorly" (Sharpe, 1897). There are a few hairs scattered over the surface of the valves and each valve is marked with three irregular brown to reddish-brown blotches. One of these is on the anterior slope of each valve, another along the dorsal margin behind the eye, and the third is on the posterior slope of each valve. The length and height of several valves of mature females are as follows:

Right		Left	
Length	*Height*	*Length*	*Height*
0.54 mm.	0.37 mm.	0.54 mm.	0.38 mm. (holotype)
0.54	0.38	0.54	0.39
0.55	0.38	0.56	0.39
0.50	0.34	0.50	0.35
0.48	0.33	0.48	0.34

The swimming setae of the antennae extend beyond the tips of the distal claws for a distance equal to three times the length of the distal claws. The sensory organ of the antenna has a length less than one-half of the length of the podomere which bears it. The terminal podomere of the mandibular palp is very long, being three times as long as the greatest width; distally it is only about one-half as wide as proximally.

The ultimate podomere bears, among others, two long setae which are at least one and one-half times as long as the ultimate podomere. On the outer margin of the penultimate podomere of the mandibular palp near the distal end is a group of four long setae which reach considerably beyond the distal margin of the ultimate podomere. The second thoracic leg with the proximal width of the ultimate podomere equal to or greater than the length of the podomere; terminal claw slightly less or equal in length to the sum of the lengths of the distal three podomeres. Antepenultimate podomere with a length equal to that of the penultimate podomere.

The penultimate podomere of the third thoracic leg (fig. 91) has a length little more than three times the greatest width and is longer than the antepenultimate podomere; the seta of the penultimate podomere arises proximal to the center of the podomere and reaches nearly to the level of the distal end of the podomere. The seta of the antepenultimate podomere reaches over a third of its length beyond the base of the seta of the penultimate podomere. A crown of bristles is present at the distal outer margin of the penultimate podomere but does not surround a distal seta as happens in many Cypria species. One of the seta of the crown is enlarged and spine-like. The ultimate podomere is a little longer than wide; the ventral margin is sinuated. Sharpe (1897) writes that the inner margin of the ultimate podomere of the third leg is sinuated; evidently he made an error in orientation of the appendage. The terminal setae of the similarly directed pair are nearly equal and but little longer than the length of the ultimate podomere which bears them. The furca (fig. 92) is somewhat curved; the length of the ventral margin is between seven and eight times the least width of the ramus. The margin of the ramus is smooth. The dorsal seta has a length less than the least width of the ramus and is removed from the subterminal claw by a distance equal to three times the least width of the ramus, being, therefore, nearer the midpoint of the dorsal margin than the distal one-third. The terminal seta is longer than the dorsal seta, having a length nearly twice the least width of the ramus. The terminal claw is gently curved and smooth. It has a length equal to five-eighths of the ventral margin of the ramus or about one-half of the dorsal margin. The subterminal claw measures a little more than three-fifths of the terminal claw and is very heavily toothed.

Description of the Male: Shell of the male the same size and shape as that of the female. The appendages are similar. Ductus ejaculatorius (fig. 93) elongate and with the general characteristics of the subfamily. Prehensile palps dissimilar and unequal. The right palp (fig. 94b) is stout, distally enlarged, with the propodus terminating in a distal process

extending beyond the dorsal margin of the heavy, hook-like dactylus. The left palp (fig. 94a) is more slender than the right, the propodus is not distally enlarged and the dactylus is narrow and distally reflexed. The penis is wide (fig. 95), with the middle lobe tapering, flap-like; the inner lobe much more slender, somewhat curved distally, having the outer margin chitinized, and shorter than the lappet-like middle lobe.

Remarks: It is unfortunate that Turner (1895) and Sharpe (1897) confused this species with the true *C. ophthalmica* described by Jurine in 1820. While certain similarities do exist, there are many conspicuous differences. G. W. Müller (1912) questioned the identification of *C. ophthalmica* as made by Turner in 1895. At the same time, Müller omitted entirely Sharpe's reference of 1897 to *C. ophthalmica* from Illinois. Whether this omission was intentional because he doubted Sharpe's identification or whether it was an oversight on Müller's part cannot now be ascertained. Though *C. ophthalmica* and *C. maculata* are closely related species, they may be separated definitely upon the following characters:

	C. ophthalmica (Jurine 1820)	*C. maculata sp. nov.*
Shell length, female	Seldom under 0.55 mm.	Seldom over 0.55 mm.
Color of shell	Most of shell covered with isolated colored patches	Three definite colored patches or areas
Antenna, sensory organ	¾ length of its podomere; almost reaches distal end of podomere	½ length of podomere and does not almost reach distal end of podomere
Third leg, distal seta of penultimate podomere	Reduced to a spine surrounded by a crown of bristles	Small, a part of the crown of bristles
Furca, length of dorsal seta	Almost twice the least width of the ramus	About the same as the least width of the ramus
Furca, dorsal margin	Toothed	Smooth
Furca, subterminal claw	Weakly toothed	Heavily toothed
Right prehensile claw of male	Propodus not much enlarged distally	Propodus much enlarged distally

There is a remote possibility that *Cypria maculata sp. nov.* should be referred to *Physocypria dentifera* (Sharpe 1897) G. W. Müller 1912. The absence, however, of the definite "tuberculiform teeth" (Sharpe, 1897) on the anterior margin of the left valve, the absence of the hyaline border along the anterior of the right shell margin, and the greater size of the shell would certainly be sufficient reason for recognizing *Physocypria dentifera* and *Cypria maculata* as apparently separate species. Occasionally a right valve of *C. maculata* may be found bearing on the anterior margin rudimentary tubercles but the writer has never found such tubercles on the margin of the left valve. As the writer has no individuals

of *Physocypria dentifera* for comparison with *Cypria maculata,* it is impossible to determine the exact relationship between the two species. Whether or not *Physocypria dentifera* represents a variable series which includes *Cypria maculata* will depend upon a detailed study made from an abundance of material of both species. Until such a study is made, Sharpe's *Physocypria dentifera* and the writer's *Cypria maculata* must stand as valid species.

Ecology: Unlike the closely related species *C. ophthalmica, C. maculata sp. nov.* is usually found in clean, alkaline waters. It may be found in vernal ponds, the shores of lakes, and along the edges of streams where the current is slowed up by the presence of aquatic plants. It seems to prefer habitats where there are algal masses, grasses, and water plants and is only in rare instances found associated with decaying vegetation.

Distribution: Through the uncertainty of the exact designation of *C. ophthalmica* as used by Sharpe (1918), it is impossible to give the corrected distribution for this species. Sharpe (1918) gives the distribution as Georgia, Illinois, Minnesota, and Oregon for *C. ophthalmica,* but since Sharpe's conception of *C. ophthalmica* was probably a mixture of the true *C. ophthalmica* of Jurine and what is herein designated as *C. maculata sp. nov.,* the distribution records are almost valueless. The present writer has taken this species from counties in nearly all parts of Illinois.

The holotype (female) and allotype (male) of this species are deposited in the U. S. National Museum (Cat. Nos. 81083 and 81084). Paratypes (male and female) are in the collections of Dr. H. J. Van Cleave, Dr. Arthur G. Humes, and the writer.

Cypria ophthalmica (Jurine 1820) Brady and Norman 1889

(Pl. VII, figs. 96-97)

Monoculus ophthalmicus Jurine 1820. Jurine, 1820:178, pl. 19, figs. 16, 17.

Cypria ophthalmica (Jurine 1820) Brady and Norman 1889. Brady and Norman, 1889:69, pl. 11, figs. 5-9.

non Cypria opthalmica (sic!) (in part?) Turner 1895. Turner, 1895:306, pl. 75, figs. 1-3, 7; pl. 76, figs. 1-3, 5.

non Cypria ophthalmica Sharpe 1897. Sharpe, 1897:466-468, pl. 47, fig. 5.

non Cypria opthalmica (sic!) Sharpe 1918. Sharpe, 1918:821, fig. 1284.

Cypria ophthalmica (Jurine 1820) Brady and Norman 1889. Kaufmann, 1900a:336-341, pl. 20, figs. 1-3; pl. 23, figs. 15, 16; pl. 29, fig. 20.

Cypria opthalmica (sic!) (Jurine 1820) Brady and Norman 1889. Sars, 1928:97-98, pl. 45, fig. 1.

Type Locality: Central Europe.

Description of the Female: An ostracod of the genus Cypria. Shell (fig. 96) short and high; seen from the side, the dorsal margin is strongly

arched, both anterior and posterior ends broadly rounded, the posterior more so than the anterior. The ventral margin is either straight or weakly sinuated in the center. There is a hyaline border along the anterior and posterior margins of the shell. The left valve is very slightly larger than the right. Measurements of several mature females from Illinois are as follows:

Length	*Height*
0.61 mm.	0.41 mm.
0.60	0.42
0.63	0.44
0.56	0.36
0.60	0.40

Surface of the valves without sculpturing but covered with pigment spots (fig. 97), each spot being made up of little flecks of pigment; these spots are usually more conspicuous along the anterior, posterior, and dorsal margins of the shell than they are in the central part of each valve.

The swimming setae of the antennae extend beyond the tips of the terminal claws a distance equal to more than three times the length of the terminal claws. The distal end of the sensory organ on the side of the antepenultimate podomere is almost at a level with the distal end of the podomere. The distal podomere of the mandibular palp is very much elongated, being three times as long as the greatest width of the podomere. The masticatory processes of the maxilla are short. The palp of the maxilla has a wide, proximal podomere and a distal podomere which is small and is attached to the ventral distal angle of the first podomere. On the distal margin, the ultimate podomere bears some bristle-like setae fully twice as long as the length of the podomere. The claw of the second thoracic leg is equal or slightly subequal to the sum of the lengths of the last three podomeres. The last podomere of the third thoracic leg is nearly as wide as long; the two shorter setae are slightly unequal, one being a little less, the other a little more than the length of the podomere to which they are attached. The penultimate podomere bears a distal seta reduced to a spine and a long seta near the basal one-third of the podomere. This latter seta reaches to the distal margin of the podomere. The margins of the penultimate and antepenultimate podomeres bear many fine hairs. The furcal ramus is stout and slightly curved. The ventral margin of the furca is approximately seven times the least width. The dorsal margin of the furcal ramus is finely toothed throughout most of its length. The apical claws are well developed, the terminal one being two-thirds the length of the ventral margin of the

ramus. The terminal seta is approximate in length to the least width of the ramus; the dorsal seta approaches twice the width of the ramus.

Description of the Male: The male is slightly smaller than the female. The coloration and general appearance is the same. In the male, the swimming setae of the antennae are shorter, extending beyond the tips of the terminal claws for a distance little more than twice the length of the claws. The prehensile palps are much unequal and dissimilar; the right one being much more highly developed as a prehensile structure than the left. The terminal lobes of the penis are well produced, the inner one being somewhat shorter and more acute at the distal end than the middle one. The males are not very numerous in any collection. This also has been noticed by Klie (1938a): "Die ♀♀ sind stets Zahlreicher als die ♂♂."

Remarks: It is very unfortunate that Sharpe (1897) mistook individuals of another species (*C. maculata mihi*) for this easily identified European species. A comparison of the species Sharpe called *C. ophthalmica* with the true *C. ophthalmica* of Jurine is made under the remarks in the description of *C. maculata sp. nov.*

Individuals assigned herein to *C. ophthalmica* agree in all important details with European descriptions of this species. The only noticeable differences are a slightly greater inequality in the two shorter distal setae of the third thoracic leg and a somewhat greater length of the dorsal and terminal setae of the furca in the American form. These differences are so slight, however, that they may be assigned to species variation. That great variation in size, shape, as well as general proportions of various structures occur in this species is well known as Kaufmann (1900a) writes: "Die Dimensionen scheinen auch bei dieser Form in den einzelnen Ländern erheblich zu differieren."

It is very improbable that *Cypria neglecta* Herrick 1879 is a synonym of *C. ophthalmica* Jurine, although both Turner (1895) and G. W. Müller (1912) consider it possible but questionable. From the size of the shell as given by Herrick (1879), "little exceeding 0.01 in.," one might reasonably suppose that Herrick examined immature individuals. His drawings (Herrick, 1879:pl. 17, figs. 2c, 2d) of the furca and the antennae ("inferior antennae") point to either immature individuals or abnormal ones although his drawing of the ductus ejaculatorius seems to be from a mature male. From the description given by Herrick, "color dull white, without markings of any kind," it is necessary to conclude that he did not have either the *C. ophthalmica* of Jurine or of Sharpe (*C. maculata*) as the color markings are without exception prominent in these two species. From Herrick's inadequate description and apparently erroneous figures,

it is not safe to reassign his *Cypria neglecta* to any known species of Cypria.

Ecology: There is a wealth of ecological data regarding this species in European waters (Kaufmann, 1900a; Alm, 1916; Klie, 1938a). In general, the species has been reported as living in "Kleineren, austrocknenden Gewässern aller Art, als auch in Grösseren Teichen und besonders am Grunde der Seen gefunden" (Alm, 1916). The present writer has collected *C. ophthalmica* only from waters which contain an abundance of decaying material and where, in some instances, the pH indicates a highly acid condition. In one collection made by the present writer from a ditch in Franklin County, Illinois, the water had a pH of 6.4. In another instance, individuals belonging to this species were collected by Robert Yapp from a cypress swamp at Reelfoot Lake, Tennessee, where the pH was 6.8. No individuals of this species have been taken from the distinctly alkaline waters of the northern part of the state of Illinois. It is evident that this species tolerates an acid condition of the water and perhaps prefers it to an alkaline condition. That this species tolerates distinctly "spoiled" waters was also noticed by Kaufmann (1900a) who writes: "Sie . . . . ist sehr widerstandsfähig gegen das Verderben des Wassers, sowie gegen Temperaturunterschiede." There appears to be no seasonal restriction upon the distribution of this species.

Distribution: In general, this species is distributed over most of the Holarctic region and South America as well (Daday, 1905). Because of the uncertainty of Turner's identification (Turner, 1895), it is impossible to state definitely the distribution previously reported for North America. However, Turner's report of its occurrence in Georgia is probably correct. The report by Dobbin (1941) of this species in the Pacific region constitutes without doubt a valid record since her description checks closely with the present writer's. This species has been collected in several counties of central and southern Illinois. The writer has also found *C. ophthalmica* in collections made by Mr. Robert Yapp in the vicinity of Reelfoot Lake, Tennessee.

Genus PHYSOCYPRIA Vávra 1897

The margin of either the right or the left valve has a row of tubercles or pustules which may be confined to the anterior margin alone or may be found on portions of the anterior, posterior, and ventral margins. Otherwise as in the genus Cypria.

Two species of this genus, *P. pustulosa* (Sharpe 1897) G. W. Müller 1912 and *P. dentifera* (Sharpe 1897) G. W. Müller 1912, are known from Illinois.

KEY TO SPECIES OF THE GENUS PHYSOCYPRIA IN ILLINOIS

a. Many tubercles along the anterior margin and a few to many along the posterior margin of the right valve (fig. 98); terminal claw of the furca equal approximately to one-half of the length of the ramus..... .....*P. pustulosa* (Sharpe 1897) G. W. Müller 1912

b. Many fine tubercles along the anterior margin only of the left valve; terminal claw of the furca approximately equal to three-fifths of the length of the furca.....*P. dentifera* (Sharpe 1897) G. W. Müller 1912

Physocypria pustulosa (Sharpe 1897) G. W. Müller 1912

(Pl. VII, fig. 98)

Cypria pustulosa Sharpe 1897. Sharpe, 1897:461-462, pl. 48, figs. 6-10; Kofoid, 1908:258.

Cypria (Physocypria) pustulosa Sharpe 1897. Sharpe, 1918:821, figs. 1284a, b, c, d, e.

Physocypria pustulosa (Sharpe 1897) G. W. Müller 1912. G. W. Müller, 1912:134; Furtos, 1933:470, pl. 16, figs. 10-11.

Physocypria globula Furtos 1933. Furtos, 1933:468-469, pl. 16, figs. 1-9.

Type Locality: Mason County, Illinois.

Description of the Female: An ostracod of the genus Physocypria. The subovoid shell (fig. 98) shows considerable variation in both size and shape. The dorsal margin forms a high arch. Both the anterior and posterior margins are rounded, the posterior more broadly. The ventral margin is usually nearly straight but may have a slight centrally located sinuation. The left valve is slightly larger than the right. The greatest height of the shell is about two-thirds of the length and is at the center of the dorsal margin or slightly anterior or posterior to the center. Seen from above the shell is compressed with the greatest width considerably less than the greatest height. Several shells of mature females from Illinois measure as follows:

Length	*Height*
0.52 mm.	0.40 mm.
0.56	0.42
0.59	0.43
0.49	0.31
0.48	0.36
0.62	0.46
0.48	0.30

The shell is moderately hairy; the eyespot is very large; the shell is marked with brown or reddish-brown blotches or patches. One of these is located anteriorly, another above and posterior to the eyespot, and the third is on the posterior part of the shell.

The most important single criterion of this species is the presence of tubercles upon the margin of the right valve. These tubercles are

highly variable in position, number, and size. The tubercles on the anterior margin of the shell are rather small and range from as few as ten to as many as twenty-five in number. A few of them may pass around the margin of the valve to the anterior end of the ventral margin. The tubercles are usually largest in the center of the row and become weaker toward the two ends, the weakest of the tubercles being barely distinguishable. The tubercles of the posterior and posterior-ventral margin present still greater variability. Occasionally they are almost unrecognizable, only rudiments appearing to mark the position of the larger tubercles. In the form described by Sharpe as *C. pustulosa* (Sharpe, 1897) there are three or four tubercles just posterior to the ventral sinuation. These are commonly not conical but are flattened and pointed posteriorly. On the right valve of other individuals (designated as *C. globula* by Furtos (1933)) these few large tubercles are followed posteriorly by a row of small, distinct tubercles along the posterior margin. The number and size of these tubercles vary; there may be only one or two or there may be nearly as many as there are tubercles on the anterior margin of the valve. With respect to the tubercles there appears to be no dividing line between the *pustulosa* form of Sharpe and the *globula* form of Furtos. This is considered further under the heading "remarks."

The swimming setae of the antennae are long, reaching a distance equal at least to three times the length of the terminal claws beyond the tips of the claws. The sensory organ of the third podomere is rather short, reaching only to the distal one-fourth of the podomere. The terminal podomere of the maxillary palp is nearly square in outline and bears distally three well developed but unequal setae and several smaller ones. The terminal podomere of the third thoracic leg is but little longer than wide. The two short distal setae are subequal, the longer one being slightly longer than the ultimate podomere of the leg. The penultimate podomere of the third leg has a long seta with the base just below the middle of the podomere and the tip reaching to the distal margin of the podomere. The podomere bears at the distal end a very small, vestigial seta and a crown of fine bristles. The inner margin of the antepenultimate and ultimate podomeres of the third leg bear numerous long hairs. The furca is long and narrow, the ventral margin usually eight to nine times as long as the least width of the slightly curved ramus. The dorsal seta varies from about one to one and one-half times the least width of the ramus and is located a little distal of the center of the dorsal margin of the ramus. The terminal seta is usually a little longer than the dorsal one. The terminal claw has a length equal to approximately one-half the length of the dorsal margin of the ramus. The sub-

terminal claw is about two-thirds the length of the terminal one. The terminal and subterminal claws are gently curved; the terminal is smooth, the subterminal has a row of fine teeth near the tip.

Description of the Male: The male is somewhat smaller than the female; otherwise similar. The prehensile palps are Cypria-like and are of little distinctive taxonomic importance. The penis has the outer lobe wanting; the inner lobe is relatively long, pointed, and curved; and the middle lobe is rather flap-like, not very wide, blunt at the distal end, and reaches about the same level distally as the inner lobe.

Remarks: Physocypria pustulosa is an extremely variable species of ostracod. The variation is evident in the shell shape; length to height ratio of the shell; the number, position, and size of the tubercles on the shell; the lengths of the setae on the third thoracic leg; and the lengths of the dorsal and terminal setae of the furca. In working with several hundred individuals selected from one hundred and thirty collections, the writer has found it impossible to divide the variable series representing this species into either morphological species or subspecies. It is possible, as Furtos (1933) may have done, to select individuals from the ends of the series and set them aside as different species based entirely upon the number and arrangement of the tubercles of the shell margin. However, when a large series is at hand, it is evident that *P. globula* Furtos 1933 and *P. pustulosa* (Sharpe 1897) are really a single species. In most population samples, it is possible to find individuals which have the typical *pustulosa* type of posterior-ventral tubercles and have in addition a few extremely small, rudimentary tubercles which might easily be overlooked. Very often, the number of pustules or tubercles on the anterior margin of the shell is distinctly too many for Sharpe's species and corresponds accurately with the number given by Furtos for the *globula* type. Posteriorly, however, the same shell may have only three large flattened pustules which are distinctly of the *pustulosa* type. In contrast, there may be several tubercles posteriorly as in Furtos's species with only a very few anterior ones as in Sharpe's species. The size of the tubercles also varies from heavy to practically indistinguishable. In many of the collections it is possible to find individuals which would be readily identified as *P. pustulosa* and some of which must be assigned to *P. globula.* In collections where two or more slides are available, it was found that upon initial examination of the material, the writer was confused and often placed one slide in the *pustulosa* group and the other slide in the *globula* group. This sorting was done upon the basis of the nature of the tubercles.

It was thought by the writer that there might be some structure other than the tubercles which would offer a definite and decisive criterion for

the separation of the species of Sharpe and that of Furtos. The writer was unable to find any such criterion and was indeed unable to find any correlation between the tubercles and the other variable characteristics of the species. In comparing the description of *P. globula* and *P. pustulosa* as given by Furtos (1933) the writer found the following differences, each of which, upon proper examination, is found to have no specific value in differentiating between the two described species:

(1) *P. globula* is said to measure 0.63 mm. in length and 0.41 mm. in height; *P. pustulosa* measures 0.62 mm. in length and 0.45 mm. in height. The writer has found that intermediates occur between these two sizes and the differences in height as well as the length to height ratio is not as large as the differences which occur in many of the more definitely limited species of Cypria. The difference in height and length to height ratio may then be dismissed as having no specific significance.

(2) For *P. globula,* Furtos gives 20 to 25 tubercles on the anterior end and three large tubercles followed posteriorly by many small ones at the posterior end; in *P. pustulosa* 12 to 17 tubercles at the anterior end and two or three large pustules at the posterior end of the ventral margin. As explained above, intergradations between the two described forms occur.

(3) According to Furtos, the longer of the pair of terminal setae of the third leg of *P. globula* is one and one-half times the length of the ultimate podomere; the longer in *P. pustulosa* is but slightly longer than the podomere. This difference is not at all significant as variation beyond these limits is not uncommon in many ostracod species. Moreover, there seems to be no correlation between the number of tubercles and the relative length of the distal setae of the third thoracic leg.

(4) The furcae, according to Furtos's descriptions, differ in some few details in the two forms. In *P. globula* the furca is said to have a length eleven times the least width of the ramus, while in *P. pustulosa* the length is nine and one-half times the least width. If one assumes that camera lucida drawings are more accurate than text descriptions, then it is apparent by measuring the drawing (Furtos, 1933:pl. 16, fig. 6) that the text description of the furca of *P. globula* is incorrect and the correct length-width ratio is more nearly nine and one-half than eleven. One may say then that there is no significant difference between the length-width ratios of the furcal rami of the two forms under discussion.

(5) Another apparent difference between the descriptions of the two species given by Furtos is that the dorsal seta of the furca in *P. globula* is removed from the distal end of the ramus by one-third of the dorsal margin of the ramus, while the dorsal seta of *P. pustulosa* is removed from the distal end of the ramus by about two-fifths of the dorsal margin of the ramus. Referring to Furtos's drawing (her pl. 16, fig. 6) of the

furca of *P. globula,* it is apparent that the dorsal seta is removed from the distal end of the ramus by at least two-fifths of the dorsal margin of the ramus. This, then, is not a significant difference between the two species.

(6) While Furtos states that the male structures are similar in *P. globula* and *P. pustulosa,* she gives the size of the former as being 0.62 mm. long and 0.39 mm. high while the latter is 0.55 mm. long and 0.39 mm. high. Such size variation has no specific significance especially since it is not correlated with any other characteristic.

The above discussion conclusively shows that the species *P. globula* can be nothing else than the end of the series which represents *P. pustulosa. P. globula* Furtos 1933 then becomes a synonym of *P. pustulosa* (Sharpe 1897).

Whether or not there may be local races of individuals clustered about one end of the series representing *P. pustulosa* is possible but not definitely known. The discovery and study of such races will not, the writer believes, destroy our conception of *P. pustulosa* as it now stands, but may add something to the knowledge of variation and species development in the Ostracoda.

Ecology: In general, *Physocypria pustulosa* prefers the quiet waters of lakes especially in areas where there is an abundance of plant life. It is occasionally found in roadside ditches over apparently bare bottom and is sometimes a constituent of plankton. The abundance of individuals of this species seems to reach a peak in June with the individuals becoming less abundant in July and August.

Distribution: P. pustulosa has been reported under the names *P. globula* and *P. pustulosa* by Furtos (1933) from various places in Ohio. Dobbin records it as *Cypria (Physocypria) globula* from Washington and Alaska. It was reported from Illinois by Sharpe (1897) and Kofoid (1908). It has been taken by the present writer in all parts of the state. When sufficient collections have been made, records of the distribution will probably be extended to all counties of the state.

Physocypria dentifera (Sharpe 1897) G. W. Müller 1912

Cypria dentifera Sharpe 1897. Sharpe, 1897:463-465, pl. 47, figs. 6-11; 1908:400, 410, pl. 50, figs. 3, 4.

Cypria (Cypria) dentifera Sharpe 1897. Sharpe, 1918:820, figs. 1282a, b, c, d.

Physocypria dentifera (Sharpe 1897) G. W. Müller 1912. G. W. Müller, 1912:133; Furtos, 1933:468.

Type Locality: Cincinnati, Ohio.

Description of the Male and Female (after Sharpe, 1897): Shell highest just posterior to the center; anterior and posterior ends rounded,

the posterior more broadly. The ventral margin has a slight sinuation near the center. The shell has dark brown markings distributed as follows: one anterior, one ventral, one "dorsal-ventral," and one vertical just posterior to the eye. Few hairs except at the anterior and posterior margins. "The anterior margin of the right valve projects as a hyaline flange, receiving as in a pocket the anterior margin of the left valve, which is armed with a row of eighteen to twenty tuberculiform teeth." Swimming setae of the second antennae reaching beyond the terminal claws a distance equal to the entire length of the antennae. Second thoracic legs stout; terminal claw much bent and as long as the last three podomeres together; the distal seta of the antepenultimate podomere two-thirds as long as the podomere. The two short setae of the third thoracic legs are approximately equal to each other and to the last podomere; the distal podomere has a sinuation on its inner edge and is two-thirds as wide as long; penultimate podomere three and three-fourths times the length of the terminal one, a plumose seta is found at its "middle point" and a comb of bristles is located distally. The antepenultimate podomere of the third thoracic leg as long as the penultimate; the rather stout seta at the distal inner angle is as long as the seta on the penultimate podomere. Caudal rami stout, about ten times as long as wide. Terminal claw three-fifths as long as the ramus; subterminal one two-thirds as long as the terminal one with a comb of long teeth near the tip. Terminal seta equals one-half of the subterminal claw in length; dorsal seta not longer than the least width of the ramus and located slightly above the center of the ramus.

Remarks: The exact identity of *Physocypria dentifera* is somewhat obscure as Sharpe seems to have been the only individual to see representatives of this species. This species, as far as appendages are concerned, bears a very close resemblance to *Cypria maculata mihi.* The principal differences between *Physocypria dentifera* and *Cypria maculata* are that the shell of the latter is smaller, the anterior margin of the left valve is not tuberculate or crenulate, and the right valve has no hyaline border. Occasionally individuals assignable to *C. maculata* may have a roughened area along the margin of the left shell but never teeth in the position, number, or shape shown by Sharpe (1897:pl. 47, fig. 6). It is possible that Sharpe worked with material which showed a development of this roughened margin into tubercles or Sharpe may have made an inaccurate observation of the true condition. Like Furtos (1933), the present writer has found no individuals assignable to *Physocypria dentifera.* As a result of a lack of material, it is impossible to compare in detail *Physocypria dentifera* and *Cypria maculata.* When such material is available, it

may be possible to show that *Physocypria dentifera* and *Cypria maculata* both belong to a series which represents a single species under the valid name of *Physocypria* or *Cypria dentifera* Sharpe 1897.

Ecology: Nothing is known of the ecology of *Physocypria dentifera* except that it was found in ponds by Sharpe (1908).

Distribution: Sharpe (1897) originally described this species from Ohio. Later he (Sharpe, 1908) gave as new records New York and New Jersey. In the same report (1908) but in the introduction, Sharpe lists Illinois, Ohio, New York, and New Jersey as the localities from which he had examined material in the U. S. National Museum. Nowhere does he give any information concerning the locality from which the Illinois material was taken. The present writer has found no individuals of this species in his collections from Illinois.

SUBFAMILY ILYOCYPRINAE

Shell oblong to subrectangular, dorsal margin usually straight and horizontal (figs. 99, 101); shell always possessing small pits, with one or more transverse median depressions, often with larger rounded hump-like projections and marginal spines. Antennules with some of the swimming setae shortened and claw-like. Swimming setae of the antenna always present, but may be greatly shortened. Antennae in male without special setae. The endopodite of the first thoracic leg not strongly developed in the female but consisting of two or three podomeres and clearly leg-like; in the male larger and transformed into a prehensile palp of two podomeres; respiratory plate well developed with six setae. Ultimate podomere of the third leg cylindrical with three setae, the longest of which may or may not be reflexed. Furca always well developed. Ductus ejaculatorius with numerous, crowded chitinous rods and with spherical inflated opening at each end. Penis with a clearly twisted vas deferens.

A single genus Ilyocypris belongs to this subfamily. Daday in 1900 introduced a second genus Iliocyprella to include *I. bradyi* and related species in which the swimming setae of the antennae are reduced and the penultimate podomere of the second leg is divided. Species like *I. gibba* with long swimming setae on the antenna and the third leg with the penultimate podomere undivided were left in the genus Ilyocypris *s. str.* Few writers have followed Daday's division of the group. Among those advocating this division is Sars (1928) who believes that Iliocyprella should be retained as the differences between Iliocyprella and Ilyocypris involve characters to which "generally a generic value has been assigned" (Sars, 1928). However, the characters used for generic diagnosis vary in different individual instances. The divided or undivided condition of

a podomere of a leg may occur in different species of the genus Candona and yet assignment to that genus is not questioned. The relative length of the swimming setae has little significance since considerable variation of length of setae is shown within many genera. The general appearance of the shell and appendages is so similar in Iliocyprella and Ilyocypris and most of the useful taxonomically important structures are so alike that there is little justification in accepting the genus Iliocyprella.

Genus ILYOCYPRIS Brady and Norman 1889

With the characters of the subfamily.

KEY TO SPECIES OF THE GENUS ILYOCYPRIS IN ILLINOIS

a. Shell with three pairs of distinct lateral projections (fig. 99-P); swimming setae of antennae reach considerably beyond the end-claws; penultimate podomere of the second leg undivided (leg of four podomeres) (fig. 100) ..... *I. gibba* (Ramdohr 1808) Brady and Norman 1889

b. Shell without well developed lateral projections, but with two shallow lateral furrows on each valve (fig. 101); swimming setae of the antennae short, almost claw-like; penultimate podomere of the second leg distinctly divided (leg with five apparent podomeres) (fig. 102-P) ..... *I. bradyi* Sars 1890

Ilyocypris gibba (Ramdohr 1808) Brady and Norman 1889

(Pl. VII, figs. 99, 100)

Cypris gibba Ramdohr 1808. Ramdohr, 1808:91, pl. 3, figs. 13, 14, 17.

Ilyocypris gibba (Ramdohr 1808) Brady and Norman 1889. Brady and Norman, 1889:107, pl. 22, figs. 1-5; Sharpe, 1908:410-411, pl. 56, figs. 1, 2; 1918:809, figs. 1257a, b; Furtos, 1933:427, pl. 1, figs. 4-7.

Type Locality: Europe.

Description of the Female: A species of the genus Ilyocypris. Shell in side view (fig. 99) with the greatest height in the region of the eye and almost equal to one-half the length. The dorsal margin nearly straight; ventral margin distinctly sinuated in the center. The anterior end appears larger and the margin more broadly rounded than the posterior. At the anterior and posterior ends of the shell there are usually conspicuous spines often set back from the margin. Three large lateral projections are found on each valve (fig. 99-P): one slightly anterior to the center of the shell and often coinciding with the muscle scars, the second dorsal and posterior to the first, and the third and smallest ventral and posterior to the center of the valve. These projections may be somewhat reduced in a small percentage of individuals. Two furrows (fig. 99-F) lie dorsal and anterior to the dorsal-anterior projection. These furrows are posterior to the eye and extend to the dorsal margin of the shell. The

surface of the shell and the margins bear numerous hairs. From above, the two most dorsal projections are easily observed on the sides of the shell. The greatest width is less than the greatest height and is posterior to the center of the shell. The length of the females vary greatly, the average being a little less that 0.95 mm.

Swimming setae of the antennae well developed but variable; usually the distal one-third of the setae extends beyond the end claws of the antennae. Penultimate podomere of the second thoracic leg (fig. 100) undivided, the leg being composed of four podomeres. Furcal ramus stout; the ventral margin a little less than twelve times the least width of the ramus; ramus gently curved with the dorsal margin spined. The dorsal seta has a length approximately equal to four times the least width of the ramus and is removed from the subterminal claw by a distance nearly equal to the length of the seta. The terminal claw is almost as long as two-thirds of the ventral margin of the ramus; the subterminal claw is little shorter than the terminal. The terminal seta has a length subequal to twice the least width of the ramus.

Description of the Male (mainly after Klie, 1938a): The shell of the male is said to be much like that of the female in shape and size. The furca of the male is more strongly curved than in the female. The two prehensile palps are similar; the propodus is long and cylindrical and the long dactylus tapers to an acute point. The middle lobe of the penis is much larger than the other lobes; it is lappet-like and the distal-inner corner is in the form of a right angle. Males have been found in northern Africa and in southeastern Russia. Males have not been reported from North America and none were found in the present writer's collections.

Remarks: The earliest reference to this widely distributed species in North America is that of Sharpe (1908) who reported *I. gibba* from Colorado. It seems rather strange that Sharpe (1897) did not find *I. gibba* in Illinois when it is now known to be very abundant. That Sharpe did not find this species in Illinois may be the result of examining little else than material collected from ponds and lakes rather than rivers and streams where it commonly occurs.

Ecology: I. gibba is a very common species found chiefly in running waters. That it is seldom found in lakes and ponds is shown by its occurrence in such habitats in only three of the forty-four collections made by the writer; the other forty-one collections were taken from streams, rivers, and pools in stream beds. *I. gibba* is found for the most part associated with vegetation and algae in current which, in some instances, is very swift. This is in contrast to the habitat reported as "sandy bottoms of large and small lakes" by Furtos (1933). It is possible that few of her collections were made from streams since this type of habitat

is usually not considered profitable for collecting ostracods. Sars (1928) reports *I. gibba* as being common in shallow ponds and "ditches with clayey bottom." Like most writers, Sars makes no mention of the occurrence in streams. G. W. Müller (1900), however, states that this species is present in every little stream as well as the backwaters of rivers and widened, shallow places in streams. It is found where the bottom mud is not too slimy and soft. The waters in which *I. gibba* is found are usually permanent but this species may at times be found in habitats, especially small vernal streams, which completely dry up in July and August. In consideration of the types of vegetation in the habitats from which this species was collected, *I. gibba* is found most abundantly in grass growing either in the water along the edge of the stream or growing on the bank and falling over into the water. In about fifteen per cent of the collections, *I. gibba* was found on the bare bottom and in about twenty-eight per cent of the collections, this species was taken from algal masses. In regard to seasonal distribution, *I. gibba* appears most abundant in the late vernal and in the aestival seasons. It was not taken by the writer earlier than May.

Distribution: *I. gibba* has been reported throughout the Holarctic region. In the United States, it was first reported from Colorado by Sharpe (1908). It has recently been recorded from Ohio by Furtos (1933). The species is more abundant and widespread than generally understood, having been taken by the present writer from counties in all parts of Illinois but with greater frequency in the northern than in the southern one-half of the state.

Ilyocypris bradyi Sars 1890

(Pl. VII, figs. 101, 102)

Ilyocypris bradyi Sars 1890. Sars, 1890:59-60; Sharpe, 1908:411-412, pl. 56, figs. 3-6; 1918:810, figs. 1258a, b, c, d.

Ilyocypris bradii (sic!) Sars 1890. Furtos, 1933:428, pl. 1, figs. 8-10.

Type Locality: Norway.

Description of the Female: A species belonging to the genus Ilyocypris. Subrectangular shell (fig. 101) with straight, almost horizontal, dorsal margin. Greatest height in the region of the eye and scarcely more than one-half of the length. Two distinct dorsal-lateral furrows are present between the center of the shell and the eye. The dorsal margin forms a corner with the posterior margin, giving the shell a rectangular appearance. The anterior and posterior ends are rounded, the former more broadly. The ventral margin has a conspicuous sinuation. From above, the somewhat compressed shell is narrowly oblong in shape with the anterior end pointed and the posterior end rounded, the left shell

slightly larger than the right, the sides of the valves flattened, and the greatest width hardly two-fifths of the length. A few spines, tubercles, and hairs decorate the margins. The shells of mature females usually average about 0.95 mm. in length.

The length of the swimming setae of the antennae seldom reach much beyond the middle, never beyond the distal margin, of the penultimate podomere of the antenna. The second thoracic leg (fig. 102) has five apparent podomeres through the division of the penultimate podomere. The third thoracic leg of *I. bradyi* is similar to that of *I. gibba* but the furca differs by the ramus of *I. bradyi* being much more curved, the dorsal seta relatively smooth and straight, and the terminal seta little exceeding the least width of the ramus. Otherwise similar to *I. gibba.*

Males: Concerning the males, Furtos (1933) says: "*Male* not recorded for Ohio. Rare elsewhere." The present writer has found no males in Illinois collections and knows of no instance in the literature where males have been definitely recorded.

Remarks: As in the related species, *I. gibba,* Sharpe (1897) probably overlooked the present species in Illinois because he did little collecting from small streams.

Ecology: Like the closely related species, *I. gibba, I. bradyi* inhabits running waters, seldom being found in ponds or lakes. Individuals are also common in pools left in stream beds after the stream has ceased to flow in late summer. The habitat of this species is similar in nearly all respects to that of *I. gibba,* and in fact *I. bradyi* and *I. gibba* are often found associated together.

Distribution: I. bradyi is known to be widely distributed in the Holarctic region. It was first reported in the United States from Colorado by Sharpe (1908). Furtos (1933) reports it from Ohio. The present writer has taken *I. bradyi* from many counties in Illinois. The majority of these counties are from the northern part of the state, none from the extreme southern part.

SUBFAMILY CYPRINAE *s. str.*

A subfamily of the family Cypridae. Shell usually reniform (figs. 105, 110); height variable but in most species about one-half of the length. Swimming setae of the antennae (fig. 1-V) either well developed or reduced, generally not reaching much beyond the end points of the terminal claws. The outer masticatory process of the maxilla with two or three spine-like setae; end podomere of the maxillary palp ordinarily cylindrical, often narrowed or widened distally. First thoracic leg with endopodite of one podomere in the female; modified in the male to form a prehensile palp of two podomeres. Third thoracic leg distally beak-like,

modified for grasping; ultimate podomere with only two well developed setae, the third being small and hook-like or wanting (fig. 1-T). Furca usually well developed and having two claws and two setae with a relatively slender ramus (figs. 107, 111).

The subfamily Cyprinae *sensu lato* as ordinarily used by many authors may be broken into three subfamilies: the Cyprinae *s. str.*, the Notodrominae, and the Cypridopsinae. Following Kaufmann (1900b) and Wagler (1937), the present writer has thought it convenient as well as advisable to use the subfamily Cyprinae in the restricted sense. The subfamily Cyprinae *s. str.* includes a number of genera. As the genera are not properly limited or defined, each writer has used whatever ones he thought convenient and applicable. Members of this subfamily are found in nearly all parts of the world. The Cyprinae *s. str.* is represented in Illinois by a few species belonging to two genera: Cypricercus Sars 1895 and Cyprinotus Brady 1885.

KEY TO GENERA OF THE SUBFAMILY CYPRINAE IN ILLINOIS

a. Margin of both valves of shell smooth (figs. 103, 105); the furcal ramus with a length more than twenty times the least width (fig. 107) ..... Genus Cypricercus Sars 1895

b. Margin of right or left valve of shell tuberculated (fig. 110); the furcal ramus with a length less than twenty times the least width (fig. 111) ..... Genus Cyprinotus Brady 1885

Genus CYPRICERCUS Sars 1895

Shell elongate, greatest height anterior to the center and in Illinois species exceeding slightly one-half of the length. The outer masticatory process with two long, toothed spine-like setae. Furca slender (fig. 107); terminal claw with a length not more than one-half of the anterior margin of the ramus but longer than three times the length of the terminal seta. An important criterion of the genus is the coils of the testis in the anterior portion of each valve (fig. 108-A). This important criterion, however, cannot always be used since the males are in some species unknown, in other species rare. The genus is found throughout the Holarctic region.

Since males are seldom seen in many species and are unknown in others, the placing of any species into this genus depends largely upon the character of the furca which has a ventral margin measuring more than twenty times the least width of the ramus. According to Sars (1928), who originally described the genus Cypricercus in 1895 to include a South African species reproducing by syngamy and characterized by a well developed furca and the peculiar coiled arrangement of the testes, the genus should be expanded to include all the Cyprinae with the extremely long furcal rami even though the males may be unknown. Some

writers (as Furtos, 1933) choose to reserve the genus Cypricercus for those species in which the males are well known and to place all forms in which the males are either little known or unknown into the genus Eucypris even though they are, because of the slender furcal rami, closely related to Cypricercus. Such a system based on the method of propagation is very artificial and is certainly not the method indicated by Sars, the original designator of the genus Cypricercus.

KEY TO SPECIES OF THE GENUS CYPRICERCUS IN ILLINOIS

1a. Shell tuberculate over entire surface (fig. 103); usually under 1.00 mm. in length.....*C. tuberculatus* (Sharpe 1908) *comb. nov.*

b. Shell not tuberculate; usually over 1.00 mm. in length.....2

2a. Size of shell of female usually more than 1.35 mm. in length; penultimate podomere of the antenna narrow, six times as long as wide, the seta which arises from the distal, posterior corner of the antepenultimate podomere widened at the base but not forming a spherical-shaped swelling; dorsal seta of the furca reaching only to base of the subterminal claw..... .....*C. fuscatus* (Jurine 1820) Sars 1928

b. Size of shell usually less than 1.35 mm. in length; penultimate podomere of antenna only four and one-half times as long as the width (fig. 1-AN), base of seta at the distal posterior corner of the antepenultimate podomere usually swollen spherical-shaped (fig. 106-B); dorsal seta of the furca reaches beyond the base of the subterminal claw (fig. 107)..... .....*C. reticulatus* (Zaddach 1844) Sars 1928

Cypricercus tuberculatus (Sharpe 1908) *comb. nov.*

(Pl. VII, figs. 103, 104)

Spirocypris tuberculata Sharpe 1908. Sharpe, 1908:406-408, pl. 50, figs. 1, 2; pl. 54, fig. 4; pl. 55, figs. 1-6; 1918:814, figs. 1267a, b, c.

Type Locality: Jackson Park, Chicago, Illinois.

Description of the Female: A species of the genus Cypricercus. Seen from the side (fig. 103), the shell is almost elliptical; the dorsal margin is a flattened arch which, along with the almost straight ventral margin, makes both ends appear broadly and evenly rounded, the anterior more so than the posterior. The greatest height lies near the center of the shell and is approximately four-sevenths of the length. From above, the shell is oval and very tumid; the valves are nearly the same size but the right, according to Sharpe (1908), may overlap slightly the left. In some individuals, however, the present writer has found that the left valve is the larger and overlaps the right valve at least anteriorly. The surface of the shell is covered with characteristic droplet-like papillae which are strikingly conspicuous. Most of the papillae bear fine hairs. The color is usually purplish brown with a light transverse band in the region of the eye and another light band near the posterior one-third of the shell. Usually there is a much darkened area between the two light colored

bands. Sharpe (1908) gives the shell dimensions as follows: length, 0.93 mm.; height, 0.53 mm.; breadth, 0.7 mm. Most of the writer's specimens measure 0.86 to 0.90 mm. in length and 0.49 to 0.51 mm. in height.

The swimming setae of the antennae extend but little beyond the ends of the terminal claws. The outer masticatory process of the maxilla has two claw-like toothed spines, one of which may be much more heavily toothed than the other. The pectinate claw of the second thoracic leg has a length equal to one and one-third times the sum of the lengths of the last three apparent podomeres of the leg. Furca nearly straight, slender as in other members of the genus Cypricercus. According to Sharpe (1908) the ratio of the length to the least width of the furca in *C. tuberculatus* is 32 to 1. This statement is not supported by his figure (1908:pl. 55, fig. 3) and it cannot be verified by the present writer who has found the ratio of the length of the ventral margin of the furca to the least width to be about 22 or 23 to 1. The dorsal margin of the furca is smooth. The dorsal seta is relatively short, reaching only to the base of the subterminal claw and being removed from the tip of the ramus by a distance equal to about twice the least width of the ramus. The terminal claw is nearly straight, obscurely pectinate near the distal end, and measuring approximately one-half the length of the dorsal margin of the furca; the subterminal claw is nearly four-fifths as long as the terminal one. The terminal seta is longer than the dorsal one, measuring about one-third as long as the terminal claw or over four times the least width of the ramus.

Description of the Male: The shell of the male is similar in size, shape, and sculpturing to that of the female. The appendages of the male are like those of the female. The prehensile palps have a stout propodus with a falciform dactylus. The dactylus of the right palp is larger than that of the left but somewhat similar in shape. The testes have their origin in the anterior one-half of the valves, where they occur as concentric circular figures. The ductus ejaculatorius is long and slender and has about twenty wreaths of supporting spines. The penis (fig. 104) has the middle and inner lobes well developed. The inner lobe is distally rounded while the middle lobe is truncate and extends beyond the end of the inner lobe.

Remarks: Cypricercus tuberculatus when described in 1908 was assigned by Sharpe (1908) to the genus Spirocypris which the same writer (1903) had previously created. Since the arrangement of the testes in Cypricercus is similar to that found in Spirocypris and the nature of the testes was the chief diagnostic character of Sharpe's genus Spirocypris, there is no valid reason for not absorbing his genus into the previously designated genus Cypricercus. The advisability of assigning the species

under discussion to the genus Cypricercus is substantiated by the placing of a very closely related species in the genus Cypricercus by Sars (1926). Sars at this time seems to have been unaware of the *Spirocypris tuberculata* of Sharpe as he says (Sars, 1926) regarding his new species, *Cypricercus horridus* Sars 1926, from Canada: "It is, however, well distinguished from any of the other known species by the very pronouncedly scabrous surface of the shell." Both *C. tuberculatus* and *C. horridus* seem to fit naturally into the genus Cypricercus because of the character of the furca and the arrangement of the testes. *C. horridus* differs from *C. tuberculatus* in having a shell of greater length, more overlapping of the right valve by the left, a more slender penultimate podomere of the antenna, and a furca in which the dorsal seta is much longer than the terminal one and which extends well beyond the tip of the ramus.

Ecology: Sharpe (1918) reports this species under the name *Spirocypris tuberculata* in "Shallow, weedy, and swampy ponds; spring." The present writer has taken this species in June from grass and algae along lake shores and from a swampy area in a small lake where there were both decaying and living plants over a mud bottom. Collections made from the same locality in August by Mr. Bertrand A. Wright and by the writer did not reveal the presence of this species.

Distribution: This species was reported as common by Sharpe (1908) from northeastern Illinois and northern Indiana. The present writer has taken the species only from McHenry and Lake Counties, Illinois. As far as known at the present time, *C. tuberculatus* appears to be restricted in habitat to the region of lakes of glacial origin in the Chicago area.

Cypricercus fuscatus (Jurine 1820) Sars 1928

Monoculus fuscatus Jurine 1820. Jurine, 1820:174, pl. 19, figs. 1, 2.

Cypris burlingtonensis Turner 1894. Turner, 1894:17-19, pl. 7, figs. 14-23.

Cyprinotus burlingtonensis (Turner 1894) Turner 1895. Turner, 1895:333-334, pl. 70, figs. 14-23; Sharpe, 1897:435-437, pl. 42, fig. 7; Furtos, 1933:446-447.

non Cypris fuscata Turner 1895 (*non* Jurine 1820). Turner, 1895:320-321, pl. 71, figs. 41-46; pl. 72, figs. 7-7p; pl. 76, fig. 9.

Cypris (Cypris) fuscata (in part) (Jurine 1820) Desmarest 1825. Sharpe, 1908: 403-405, pl. 53, fig. 3, *non* 1, *non* 2, *non* 4.

Cypris (Cyprinotus) burlingtonensis Turner 1894. Sharpe, 1918:816, figs. 1272a, b, c.

Cypris (Cypris) fuscata (in part as var. *major* G. W. Müller 1900) (Jurine 1820) Desmarest 1825. Sharpe, 1918:818, fig. 1278a, *non* b, *non* c, *non* d.

non Eucypris fuscata (Jurine 1820) var. *gigantica* Furtos 1933. Furtos, 1933:451-452, pl. 4, figs. 1-4.

Type Locality: Europe.

Description of the Female (chiefly after Klie (1938a)): An ostracod of the genus Cypricercus. Shell in side view elongated; greatest height

just posterior to the eye and more than one-half the length. The dorsal margin forms a flat arch which passes into the broadly rounded anterior margin and the narrowly rounded posterior margin without interruption. Ventral margin usually showing a very slight sinuation. From above, the shell is oval; the greatest width in the middle and more than one-half of the length of the shell; the posterior end is rounded and the anterior is weakly pointed. Length of the shell usually between 1.4 mm. and 1.5 mm.

The swimming setae of the antennae reach beyond the distal ends of the terminal claws. The penultimate podomere of the antenna has a length equal to six times the width; posterior distal seta of the antepenultimate podomere has a tapering base. The claw-like setae of the outer process of the maxilla are toothed. The ramus of the furca is very narrow, the ventral margin having a length equal to twenty-five times the least width of the ramus. The terminal claw has a length less than one-half of the ventral margin of the ramus and the dorsal seta reaches only to the base of the subterminal claw.

Male: Unknown.

Remarks: Sharpe seems not to have recognized *C. fuscatus* as such in 1897 but he (1897) described some individuals which no doubt belonged to this species under the designation *Cyprinotus burlingtonensis* (Turner 1894) Turner 1895. At the same time, Sharpe apparently applied the name *Cypris fuscata* to what herein is designated as *Cypricercus reticulatus.* The exact identity of the *Cypris burlingtonensis* of Turner (1894) appears to have been for some time in doubt, so much in fact that G. W. Müller (1912) in the volume on ostracods in "Das Tierreich" series listed it under the heading *"Genera dubia et species dubiae Cyprinarum."* At the time of the original description of *Cypria burlingtonensis* by Turner, the descriptions of the now designated *Cypricercus fuscatus* from Europe (type locality) were so confused with other related species that he may readily have been unable to establish identity with the European *fuscata.* Thus he was forced to describe his material as a new species. The mere creation of a synonym would not have created much disturbance but Turner later (1895) changed his species *burlingtonensis* from the genus Cypris to the genus Cyprinotus. This may or may not have been correct at that time as the original diagnosis of the genus Cyprinotus as given by Brady (1885) was very inadequate. This incomplete generic diagnosis may have led Turner to assign his *burlingtonensis* to the genus Cyprinotus. The genus Cyprinotus has since then, however, been emended and accepted by most authors to include species which like the type species, *Cyprinotus cingalensis* Brady 1885, has a

row of denticles along the margin of the right valve, or in some species along the margin of the left valve. Evidently both Turner (1895) and Sharpe (1897) accepted the genus Cyprinotus without reference to the denticles of the valve margin. Sharpe (1897), however, seems to have noticed something peculiar about *burlingtonensis* since he is led to state that it "greatly resembles *Cypris fuscata* Jurine in many respects." Furtos (1933) continued to carry *burlingtonensis* without question in the genus Cyprinotus although she saw no ostracods in Ohio assignable to this species and even states (1933) that no mention was made by Turner of marginal tubercles. At the same time she gives as a characteristic of the genus Cyprinotus (Furtos, 1933) that the margin of the right valve is more or less tuberculated. Certainly there are no tubercles on the margin of the valves in Turner's *Cypris burlingtonensis.* According to recent generic diagnosis, this cannot belong to the genus Cyprinotus. Both the nature of the shell and the form of the furca indicate a close relationship with species of the genus Cypricercus. Thus *burlingtonensis* must be placed in the genus Cypricercus. Once this is done, it is obvious that *burlingtonensis* agrees in practically every respect with *Cypricercus fuscatus,* especially when a close study is made of Turner's illustrations (Turner, 1894:pl. 7, figs. 14-23). Not only is the identity shown by the morphological structure but some substantiation of this synonymy is offered by ecological data since both *C. fuscatus* Jurine and Turner's *Cypris burlingtonensis* are vernal species found usually in temporary pools where the animals live in the decaying vegetation of the previous summer. On the basis of the above arguments, there can be no doubt that *Cyprinotus burlingtonensis* (Turner 1894) Turner 1895 must become a synonym of *Cypricercus fuscatus* (Jurine 1820) Sars 1928.

In regard to *Eucypris fuscata* var. *gigantica* described by Furtos in 1933, it is definitely not equivalent to *C. fuscata* from which it differs in many important respects. On the basis of these differences, the present writer holds the opinion that *gigantica* should be raised from subspecific to specific rank.

Sharpe (1908, 1918) did not differentiate very clearly between the now designated *Cypricercus fuscatus* (his *Cypris fuscata* var. *major* G. W. Müller 1900) and the herein designated *Cypricercus reticulatus* (his *Cypris fuscata* var. *minor* G. W. Müller 1900), although he did recognize that the two different forms occurred. His drawings are often of the *minor* variety (*C. reticulatus*) but labeled as being of the *major* variety (*C. fuscatus*). This is unfortunate and shows perhaps that he was unable to distinguish clearly between the now designated species *C. reticu-*

latus and *C. fuscatus*. The following table is designated to facilitate separation of these two closely related species:

	C. fuscatus (Jurine 1820) Sars 1928	*C. reticulatus* (Zaddach 1844) Sars 1928
Shell:		
Size, female	1.4-1.5 mm. long	1.0-1.3 mm. long
Dorsal margin	Flat, even arch	Rounded, obtuse angle at highest point
From above	Anterior end more acute than posterior	Both ends equal in shape
Antenna:		
Penultimate podomere	Length six times the width	Length four and one-half times the width
Posterior distal seta of antepenultimate podomere	Tapering basal portion	Spherical basal portion
Furca:		
Ratio of length to least width of ramus	25 : 1	22 : 1
Dorsal seta	Scarcely reaches beyond base of subterminal claw	Extends beyond the base of the subterminal claw
Terminal claw	Shorter than one-half of ventral margin of ramus	Nearly equals one-half of ventral margin of ramus
Terminal seta	Length less than one-third of subterminal claw	Length more than one-third of subterminal claw

Ecology: Cypricercus fuscatus is found in grassy ponds and swamps both in North America (Turner, 1894; Sharpe, 1908) and in Europe (Klie, 1938a). This species has but a single generation each year. Individuals may be found in the prevernal, vernal, and early part of the aestival season in Illinois.

Distribution: C. fuscatus is found throughout the Holarctic region. It was reported as *Cypris burlingtonensis* by Turner (1894) from Burlington, Ohio; Atlanta, Georgia; and Kent County, Delaware. Under the same designation, Sharpe (1897) reported this species from Normal, Illinois. Later Sharpe (1908) reported this species as *Cypris fuscata* var. *major* from the region of Chicago, Illinois, and the northwestern corner of Indiana. Shelford (1913) lists *Cypris fuscata* Jurine as occurring in a temporary pond south of Jackson Park, Chicago, Illinois. Sharpe, according to a personal conversation with Dr. V. E. Shelford, identified this material and the present writer believes that it may have included both *Cypricercus fuscatus* and *C. reticulatus*. The writer has not discovered individuals of this species in his collections but this may be expected as no early spring collections were made from the region immediately southeast of Chicago, Illinois, where this species appears to be more or less localized as far as the state of Illinois is concerned.

Cypricercus reticulatus (Zaddach 1844) Sars 1928

(Pl. I, fig. 1; pl. VII, fig. 105;
pl. VIII, figs. 106-109)

Cypris reticulata Zaddach 1844. Zaddach, 1844:34; Sharpe, 1897:441-442, pl. 43, figs. 3, 4.

Cypris affinis S. Fischer 1851. S. Fischer, 1851:160, pl. 10, figs. 9-11.

Cypris fuscata Sharpe 1897 (*non* Jurine 1820). Sharpe, 1897:442-443, pl. 43, fig. 5.

Cypris testudinaria Sharpe 1897. Sharpe, 1897:444-445, pl. 44, figs. 1-4.

Cypris (Cypris) fuscata (in part) Sharpe 1897 (*non* Jurine 1820). Sharpe, 1908: 403-405, pl. 53, figs. 1, 2, 4, *non* 3.

Cypris (Cypris) fuscata (in part as var. *minor* G. W. Müller 1900) Sharpe 1897 (*non* Jurine 1820). Sharpe, 1918:818, fig. 1278b, c, d, *non* a.

Eucypris affinis hirsuta Furtos 1933 (*non* Fischer 1851). Furtos, 1933:450-451, pl. 2, figs. 9-11, 16.

Type Locality: Germany.

Description of the Female: An ostracod of the genus Cypricercus. In side view (fig. 105), the shell appears subtriangular with the height considerably greater than one-half of the length. The greatest height lies anterior to the middle where the dorsal margin forms a rounding, obtuse angle. Both the anterior and posterior slopes of the dorsal margin are equally slanted and pass without interruption into the margins of the two ends. The anterior end is more widely rounded than the posterior. The ventral margin shows a slight sinuation. Viewed from above, the shell appears broadly elliptical with the greatest width in the center of the shell and more than one-half the length. The ends are somewhat obtusely rounded, neither being acutely pointed. The length of the shell varies, individuals occasionally being as small as 1.00 mm. or as large as 1.30 mm. The young of this species bears characteristic shell sculpturing regarding which Zaddach (1844) in his original description of *Cypris reticulata* says: "Superficies lineis reticulatis et quasi insculptis ornata est, colore olivaceo, maculis nigricantibus." The shell of the adult is not sculptured.

The swimming setae of the antennae extend beyond the ends of the terminal claws. The penultimate podomere of the antenna has a length only four and one-half times the width; the posterior distal seta (fig. 106-B) of the antepenultimate podomere has a spherical basal portion. The claw-like setae of the outer masticatory process of the maxilla are toothed. The ventral margin of the furcal ramus (fig. 107) has a length twenty-two times the least width of the ramus. The terminal claw is equal to one-half of the length of the ventral margin of the ramus. The distal end of the dorsal seta reaches beyond the base of the subterminal claw and the terminal seta is considerably longer than the dorsal one.

Description of the Male: A single male specimen assignable to this species was available for study. This specimen was in poor condition, having been preserved for over forty years as a part of the collection of material in the "Field Zoology" Laboratory at the University of Illinois. The shell (fig. 108) is very flexible and thin, being little calcified. The surface of the valves are covered with fine hairs. The general shape is similar to that of the female. The testes (fig. 108-A, P) may be seen readily through the surface of each valve. In addition to the part of the testis always found in the posterior part of each valve, there is in this species an extension in the form of whorls in the anterior one-half of each valve. The appendages of the male are similar to those of the female. The prehensile palps offer no specific distinction. The ductus ejaculatorius is elongated and cylindrical with more than thirty whorls of spines. The penis (fig. 109) has a substantial inner lobe with a broadly rounded distal end; the middle lobe is thin and falciform in shape with the distal point directed toward the inner edge of the penis. In the writer's single specimen, a thin very much reduced flap may be distinguished on the outer edge of the penis. Whether or not this is actually the rudiments of an outer lobe cannot be determined with certainty because of lack of material. Alm (1914:pl. 1, fig. 3) shows no such outer appendage. The size of the male as given by Alm (1914) is 1.1 mm. to 1.2 mm. in length and the dimensions given for *Cypris testudinaria* by Sharpe (1897) is 1.15 mm. in length, 0.74 mm. in height, and 0.65 mm. in width. The length of the individual in the present writer's collection exceeds slightly 1.3 mm. in length but since the shell is very flexible and has been much flattened and distorted in mounting, this size certainly far exceeds the actual length in the undamaged animal.

Males are seldom seen in most collections and seem, indeed, to be more common in the colder parts of the range of this species. Sharpe (1908) reported, under the designation *Cypris fuscata* var. *minor,* the males as common in the Chicago region. Alm (1914) mentions under the name *Eucypris affinis hirsuta* Fischer (*E. fuscata minor* G. W. Müller) the presence of males in Newfoundland, Greenland, and Siberia.

Remarks: Cypricercus reticulatus (Zaddach 1844) is a variable species which has caused considerable confusion in the literature as a result of the morphological variation between young and adult and male and female. Much confusion has also been occasioned by the inability of investigators to separate this species from closely related species because the minute details of structure used in the differentiation were until recently unknown or misunderstood.

It is unfortunate that the name delegated to the young of this species, *reticulatus,* by Zaddach (1844) has not been retained by recent writers

on this group. For a number of years it was thought to be a species separate from the adult described by Fischer in 1851 under the name *Cypris affinis.* Sharpe (1897) did not realize that he had the young and mature of the same species and so continued to designate them separately. The sparsity of collections which contain both young and mature individuals contributed to the inability of recognition of the young which are characterized by a shell sculpturing lacking in the adult. Since there is a single generation each year and the transition from the "reticulatus" to the "affinis" type appears to take place more or less simultaneously in individuals of a given population, young and mature individuals are seldom found in the same collection.

The present writer is certain that he has the *Cypris reticulata* described by Zaddach and he is also certain that it is the young of the *Cypris affinis* of Fischer. European writers as Sars (1928), Wagler (1937), and Klie (1938a) give *reticulatus* as an unquestioned synonym of *affinis.* These same writers, however, continue to use the name *affinis* in spite of the fact that *reticulatus* has priority and should be the valid designation for this species. Sars (1928) states his reason for not using the earlier name, *reticulata,* as follows: "The specific name *reticulata* proposed by Zaddach and assigned by some recent authors to this species must, I think, be wholly discarded, as only applying to immature specimens." Such neglect of the name *reticulata* is in direct contradiction to that part of the International Rules of Zoological Nomenclature which reads as follows: "Article 26. The Law of Priority obtains and consequently the oldest available name is retained: . . . . (b) When any stage in the life history is named before the adult." Unfortunately then, *Cypricercus reticulatus* must replace *C. affinis* as the valid name for the species under consideration.

Besides separately naming the young and adult of *C. reticulatus,* Sharpe (1897) apparently also named the males, designating them as a new species, *Cypris testudinaria.* Even though there is much similarity between males and females, Sharpe seems not to have recognized the identity of his male specimens. The reason for establishing a new species for the males was probably that the males of the now designated *C. reticulatus* were unknown in the literature at the time of Sharpe. In fact, Sars recently (1928) reported the males as unknown in spite of the fact that Alm described males as early as 1914. The description given by Sharpe (1897) for *Cypris testudinaria* agrees favorably with the description of males given by Alm (1914) under the designation *Eucypris affinis hirsuta.* As far as the *Cypris testudinaria* of Sharpe is concerned, his description is evidently based entirely upon male specimens for he particularly stresses the nature of the ductus ejaculatorius (Sharpe, 1897) but nowhere refers to the females.

The designation *Cypris fuscata* which Sharpe (1897) used for the species under discussion was certainly an error on his part resulting apparently from the inavailability of good descriptions of the closely related European species belonging to the genus Cypris. At the time of Sharpe, the exact identification of many of the European species of the genus Cypris was in doubt and no two authors agreed on the valid name or the identity in many of the species.

While *Cypricercus fuscatus* and *C. reticulatus* are closely related, there are several differences in structure upon which differentiation between species can be based. These structures were undescribed in early literature but are now well known and may be applied toward straightening out the synonymy of *C. fuscatus* and *C. reticulatus.* A comparison of the morphological differences separating *C. fuscatus* and *C. reticulatus* is given in the "remarks" under the description of the former. In spite of the fact that Sharpe in 1897 did not mention most of the structures now used as a basis for separation of *C. fuscatus* and *C. reticulatus,* there are certain minor differences such as shell shape, the general shape of the furca, and the relative lengths of the setae and claws of the furca, which clearly indicate that many of Sharpe's figures (1897:pl. 43, fig. 5; 1908:pl. 53, figs. 1, 4; 1918:figs. 1278c, d) illustrating his *C. fuscatus* are drawn from species assignable to *C. reticulatus* rather than to *C. fuscatus.*

Other writers besides Sharpe have been confused over the proper designation of this species. Furtos (1933) was aware that Sharpe's *fuscata* of 1897 was not the true *fuscata* of Jurine, and yet she unfortunately adopted Alm's designation of this species, *Eycypris affinis hirsuta* (Fischer), rather than the more nearly correct *Cypricercus affinis* as used by Sars and other European writers. It is now generally known that Alm (1916) made an error in assigning *hirsuta* as a subspecies of *affinis* for the two forms differ specifically in many ways. Chief among these differences (Klie, 1938a; Sars, 1928) is the smooth nature of the claws of the outer masticatory process in *C. hirsuta* and the toothed condition in *C. affinis.* The individuals described by Furtos (1933) were characterized by having toothed claws on the outer masticatory process and so cannot belong to the species *C. hirsutus* (Fischer 1851) Sars 1928.

Ecology: C. reticulatus is typically a species of vernal ponds. Very rarely it may be found along the edge of pools in vernal streams where there remains decaying grass from the previous growing season. It is associated with live and dead grass and algae. There appears to be a single generation each year. The young appear in the prevernal season before the ice has completely disappeared. The juveniles are characterized

by a reticulated sculpturing on the shell and may be found not later than the last of April at the latitude of Urbana, Illinois. Beginning with the first of May, only individuals lacking the sculpturing and therefore considered to be approaching maturity may be found. The eggs survive the drying up of the pond during the serotinal season and hatch at the end of the haemal season. Such a life cycle is also shown by Alm (1916) for this species under the designation *Eucypris affinis hirsuta* in Europe.

Distribution: Cypricercus reticulatus is common throughout the Holarctic region. Under the designation *Eucypris affinis hirsuta,* Alm (1914) described it from the Arctic region of North America. Sharpe (1897) reported it under a variety of names from Illinois, chiefly from the east central part of the state. Later (1908) he reported it from the Chicago region. In the writer's collections are specimens taken in March, 1940, from a pond near Reelfoot Lake, Tennessee, by Mr. Robert Yapp. The writer has this species in a collection made by Mr. F. R. Cagle in Jackson County, Illinois. This material was given the present writer by Dr. Victor Sprague who received it from Mr. Cagle. The writer has collected individuals of *C. reticulatus* from the following counties in Illinois: Champaign, Piatt, Vermilion, and Woodford.

Genus CYPRINOTUS Brady 1885

Form of shell variable, greatest height equal to or greater than one-half the length. The dorsal margin may be evenly arched or may have an obtuse apex (fig. 110). Valves commonly unequal; either the right or left valve may be the longer. Margin of one valve ornamented with small tubercles along part or all of the free margin; the margin of the other valve smooth. Swimming setae of the antennae well developed. The outer masticatory process of the maxilla with two claw-like setae which may or may not be toothed. Furca (fig. 111) moderately developed, the dorsal seta commonly longer than the terminal seta and located close to the subterminal claw. The terminal claw of the furca is longer than one-half the length of the ventral margin of the furcal ramus. The genus Cyprinotus is practically cosmopolitan. Two species are known from Illinois.

KEY TO SPECIES OF THE GENUS CYPRINOTUS IN ILLINOIS

a. Left valve of shell larger than the right valve; dorsal seta of furca with a length about equal to one and one-half times the length of the terminal seta (fig. 111) ..... *C. incongruens* (Ramdohr 1808) Turner 1895

b. Left valve of shell smaller than the right valve; dorsal seta of the furca has a length equal to about twice the length of the terminal seta..... ..... *C. pellucidus* Sharpe 1897

Cyprinotus incongruens (Ramdohr 1808) Turner 1895

(Pl. VIII, figs. 110, 111)

Cypris incongruens Ramdohr 1808. Ramdohr, 1808:86, pl. 3, figs. 1-12, 15, 18-20; Turner, 1893:8, pl. 2, figs. 17-21.

Cyprinotus incongruens (Ramdohr 1808) Turner 1895. Turner, 1895:330-331, pl. 68, figs. 9-16.

? *Cyprinotus pellucida* Sharpe 1897. Sharpe 1897:434-435, pl. 42, figs. 1-6.

Cypris incongruens Ramdohr 1808. Sharpe, 1908:405-406, pl. 54, figs. 1-3.

Cypris (Cyprinotus) incongruens Ramdohr 1808. Sharpe, 1918:815, fig. 1270a, b, c, d.

Cyprinotus incongruens incongruens (Ramdohr 1808) Turner 1895. Furtos, 1933: 447-449, pl. 4, figs. 8-12.

Type Locality: Europe.

Description of the Female: An ostracod of the genus Cyprinotus. In side view (fig. 110), the right shell is elongated, highest just posterior to the center, the greatest height being about three-fifths of the length. The dorsal margin is arched and often has a slight sinuation just anterior or posterior or both anterior and posterior to the apex in at least one of the valves. The ventral margin has a slight sinuation in the center. In a view from above, the left valve overlaps the right. The shell is widest at its posterior one-third; anterior more acutely pointed than the posterior. The greatest width is about eighty-five per cent of the greatest height. The anterior and the ventral-posterior margins of the right valve are ornamented with a row of tubercles. The margins of the left valve are smooth. The length of the shell of the adult varies from 1.4 to 1.75 mm. and the color varies from a yellow to a brownish-yellow.

The natatory setae of the antennae extend beyond the tips of the terminal claws; the claw-like setae of the outer masticatory process of the maxilla are toothed. The furca (fig. 111) is stout, slightly bowed, with the terminal claw having a length about one-half the length of the dorsal margin of the furcal ramus. The length of the ventral margin of the furca is about eleven times the least width of the furca. The terminal seta has a length about one-half to two-thirds the length of the subterminal claw of the furcal ramus; the dorsal seta has a length about one and one-half times the length of the terminal seta and is removed from the subterminal claw by a distance equal to little more than the least width of the ramus. The subterminal claw measures approximately two-thirds the length of the terminal one.

Description of the Male (after Klie, 1938a): The present writer has found no males in his collections from Illinois. In the shell of the male, the greatest height lies in the middle. The shell is smaller than that of the female, measuring usually about 1.2 mm. in length. The prehensile palps are dissimilar and unequal; the right palp has a heavy propodus and the dactylus is swollen, being falciform and tapering gradually to a

blunt distal point; the left palp has a dactylus which is recurved and slender, having an even width throughout about the distal two-thirds of its length. The penis has only two lobes; the inner lobe is short and has a wide subtruncate distal margin; the middle lobe which extends distally beyond the inner is triangular in shape and the blunt point is directed toward the inner margin of the penis. The males are not common in many localities.

Remarks: This species was first reported from North America by Turner who included with his description drawings (1893:pl. 2, figs. 17-21) sufficiently accurate to allow verification of his determination. G. W. Müller (1912) questions Turner's identification of this form as expressed by the latter in 1895. Turner's drawings in 1893 are much better than those in 1895 and certainly Müller was justified in his criticism of the 1895 determination.

There is a possibility that *C. pellucidus* Sharpe 1897 (Sharpe, 1897, 1903) may be a species based on immature individuals of *C. incongruens.* Sharpe's drawings of the shell of *C. pellucidus* never show the gonads indicative of a mature animal. A discussion of this possible synonymy is given under the "remarks" in the description of *C. pellucidus.*

Ecology: Sharpe (1918) gives the habitat of this common species as "temporary ponds and watering troughs." Furtos (1933) reports it from a rock-pool along the shore of Lake Erie in Ohio. It is the general consensus of opinion among European workers (Alm, 1916; Sars, 1928; *et al.*) that this species is found in puddles, ponds, and ditches. The present writer has taken it more times from running waters than he has from temporary ponds and ditches. Not only is this species found along the edge in grass and vegetation of shallow, quiet waters but it may be taken from masses of algae which hang in swiftly running water. The kind of bottom seems to have no significance as individuals may be found equally abundant over sand as over mud bottom. The writer's collections were made in the aestival season but whether or not this gives any information upon the seasonal occurrence may be doubted especially since Alm (1916) found this species abundant throughout most of the year in Sweden.

Distribution: Cyprinotus incongruens is cosmopolitan except that it has not been reported from Australia (Klie, 1926a). In North America, it was reported first from Ohio by Turner (1893) and then by Furtos (1933). Sharpe (1897) reported it from Florida and later (1908) from Pennsylvania. Alm (1914) found it in material from Greenland, and Dobbin (1941) has reported it from Oregon. The present writer has found it in collections from several counties in the northern one-half of Illinois. It has not been found in the southern part of the state.

Cyprinotus pellucidus Sharpe 1897

Cyprinotus pellucida Sharpe 1897. Sharpe, 1897:434-435, pl. 42, figs. 1-6.

Cypris pellucida (Sharpe 1897) Sharpe 1903. Sharpe, 1903:988-989, pl. 68, figs. 1-5; Weckel, 1914:178, figs. 7, 8.

Cypris (Cyprinotus) pellucida (Sharpe 1897) Sharpe 1903. Sharpe, 1918:815, figs. 1269a, b, c, d, e, f.

Type Locality: Illinois.

Description of the Female (after Sharpe, 1897, 1903): A species of the genus Cyprinotus. Shell from the side, nearly elliptical, elongate; dorsal margin evenly arched with the greatest height near the center. The ventral margin is nearly straight, but with a slight sinuation near the center. The anterior and posterior ends rounded, the posterior more broadly. In view from above, according to Sharpe's figures (1897:pl. 42, fig. 2; 1903:pl. 68, fig. 2), the left valve is slightly smaller than the right; the anterior end is rather acutely pointed, the posterior more blunt. However the text of Sharpe's description of 1903 reads as follows: "The right valve of shell is slightly smaller than the left, its anterior margins armed with a row of about twenty-five tuberculiform teeth. The margin of the left valve has a rather wide hyaline flange and a row of scattered tubercles along the inner margin." The size of individuals range from 1.1 mm. to 1.4 mm. long, 0.80 mm. high and 0.51 mm. wide.

The swimming setae of the antennae reach but little beyond the distal ends of the terminal claws. The claw-like setae of the outer masticatory process of the maxilla are toothed. The furca is stout, slightly bent, and about twice as long as the terminal claw. The subterminal claw is about three-fourths of the length of the terminal one. The dorsal seta has a length about equal to the length of the subterminal claw and is removed from the base of the subterminal claw by a distance less than the least width of the furcal ramus. The terminal seta is about one-half as long as the dorsal seta.

Males: Unknown.

Remarks: The present writer has found it impossible to determine exactly what Sharpe had when he described *Cyprinotus pellucida* (sic!) in 1897. The writer believes that Sharpe may have founded his species upon immature individuals since he does not show the ovaries in the drawings of the shell even though he states that the shell is very transparent. In almost every morphological detail, the descriptions given by Sharpe (1897, 1903, 1918) for this species checks accurately with immature individuals of *Cyprinotus incongruens.* It is, however, impossible to reconcile the shell differences in valve overlap in *C. incongruens* and *C. pellucidus.* In adult *C. incongruens* the left valve overlaps the right and the same condition is usually found in the young with the exception that in some young individuals the valves appear equal in size. Regard-

ing *C. pellucidus,* Sharpe (1903) states that the right valve is smaller than the left. In his drawings, however, in 1897, 1903, and 1918, the right valve is always shown as the larger. If the text of his 1903 description is correct and the left valve is larger than the right, then possibly *C. pellucidus* is a synonym of *C. incongruens.* On the other hand, if the left valve is consistently smaller than the right (as shown in the drawing by Weckel (1914, fig. 7)), then *C. pellucidus* must be retained as a valid species.

The unsatisfactory and uncertain manner in which the genus Cyprinotus was diagnosed in the first decade of the present century is shown by Sharpe transferring his species *pellucida* from the genus Cyprinotus to the genus Cypris in 1903. Part, at least, of this uncertainty was the result of several writers about 1900 attempting to characterize certain genera by the manner of propagation in the included species. Since the genus Cyprinotus was thought to contain only species whose individuals reproduced by syngamy, it was necessary to exclude the species *C. pellucidus* because males were and still are unknown. Later, this criterion was practically neglected and the genus Cyprinotus reconstructed along entirely morphological lines. Because the manner of reproduction varies in morphologically united groups of ostracods, it is not possible to use the manner of reproduction as a generic criterion.

Ecology: Sharpe (1897) reports this species from a roadside ditch and from a creek, as well as from an aquarium started with material from a creek. Later (1903) he reported it from a trough fed by a spring (Idaho).

Distribution: Sharpe (1897) described this species from material taken in Adams, Mason, and Champaign Counties, Illinois. Later, he (1918) gave the range of this species as Washington, Idaho, Illinois, and Mexico. The present writer has not rediscovered this species in Illinois.

SUBFAMILY NOTODROMINAE

Distal podomere of the antenna long and slender; swimming setae extend far beyond the terminal claws. Outer masticatory process of the maxilla with six nearly equal, spine-like, toothed setae (fig. 113). Third thoracic leg with three unequally long setae. Ductus ejaculatorius with chitinous supporting rays not arranged in regular rows.

KEY TO GENERA OF THE SUBFAMILY NOTODROMINAE IN ILLINOIS

a. Antenna of six apparent podomeres; first thoracic leg without respiratory plate; distal three setae of third thoracic leg unmodified; terminal seta of the furca wanting (fig. 114).....Genus Notodromas Lilljeborg 1853

b. Antenna of five podomeres; first thoracic leg with a respiratory plate; setae on distal end of third thoracic leg modified for grasping; terminal seta of furca present.....Genus Cypris Zenker 1854

Genus NOTODROMAS Lilljeborg 1853

Shell short with the height at least two-thirds of the length; dorsal margin forming an elevated arch; ventral surface flattened (fig. 112). Eyes well separated. The antenna with the penultimate podomere divided and so appearing to consist of six podomeres; the apparent distal podomeres long and slender, the swimming setae extending beyond the tips of the terminal claws. The respiratory plate of the first thoracic leg is lacking. The palps of the maxillae in the male are not similar; each is formed of two podomeres. Ultimate podomere of third thoracic leg small and with three almost equal setae. Furca with the terminal seta wanting; the dorsal seta very heavy and not far removed from the subterminal claw (fig. 114). A genus with few species: one from Sumatra, one from Ceylon, and one from the Holarctic region (Sars, 1928).

Notodromas monacha (O. F. Müller 1776) Lilljeborg 1853

(Pl. VIII, figs. 112-114)

Cypris monacha O. F. Müller 1776. O. F. Müller, 1776:199.

Notodromas monachus (O. F. Müller 1776) Lilljeborg 1853. Lilljeborg, 1853:95-102, pl. 8, figs. 1-15; pl. 12, figs. 1, 2; pl. 25, fig. 16; Herrick, 1882:252.

Notodromas monacha (O. F. Müller 1776) Lilljeborg 1853. Sharpe, 1908:417-419, pl. 59, figs. 1-8; Shelford, 1913:144, fig. 94; Sharpe, 1918:808, figs. 1255a, b, c, d, e.

Type Locality: Europe.

Description of the Female: A species of the genus Notodromas. Shell with the greatest height about seven-tenths of the length; greatest height slightly posterior to the middle of the elevated dorsal margin. Posterior end more broadly rounded than the anterior; ventral margin nearly straight and produced posteriorly into a point beyond the posterior shell margin. From above, ovate with greatest width behind the middle and equal to two-thirds of the length. Length 1.1 mm.

The ultimate podomere of the antenna equal in length to the penultimate; the swimming setae of the antenna reach the tips of the single terminal claw. Furca curved, with the terminal claw greatly exceeding in length one-half of the ventral margin of the furca.

Description of the Male: Male with shell (fig. 112) larger than female; ventral margin bowed without a posterior tooth-like projection. Length of shell 1.2 mm. Appendages as in the female. Prehensile palps well developed and dissimilar; furca (fig. 114) more curved than in the female.

Remarks: A detailed description of *N. monacha* is not needed here since Sharpe in 1908 adequately described and figured this species from material taken in northwestern Indiana.

Ecology: N. monacha has been reported by Sharpe (1908) as living in "permanent bodies of pure fresh water which is also rich in aquatic vegetation." The single male individual of this species taken by the writer was collected from the shore of a lake where there was an abundance of aquatic plants. This species is rare as this single individual was found in one of more than seventy-five collections made by Mr. Bertrand A. Wright and by the writer at different times from the lakes in McHenry and Lake Counties, northwest of Chicago, Illinois.

Distribution: N. monacha has been reported from Minnesota by Herrick (1882) and from northern Indiana (near Chicago, Illinois) by Sharpe (1908) and Shelford (1913). Dobbin (1941) reports it from Alaska. The present writer's collection was made on June 29, 1940, from south of Waucanda, Lake County, Illinois. In general, this species is widely distributed throughout the Holarctic region.

Genus CYPROIS Zenker 1854

Shell from the side, short and high, greatest height about two-thirds of the length; ventral side of the shell not flattened. Eyes not widely separated. Antennae of five podomeres; the penultimate podomere not divided; the ultimate podomere small with several end claws. The swimming setae almost reach the tips of the end claws. Right and left prehensile palps of male differing little. First thoracic leg with a well developed respiratory plate. Ultimate podomere of the third leg small, being partially enclosed by the penultimate podomere. Distally, the third leg forms a seizing apparatus similar to that found in the members of the subfamily Cyprinae *s. str.;* with only two conspicuous distal setae, the third being reduced to a tooth-like structure. Furca with two claws and two setae. A single species is found in Illinois.

Cyprois marginata (Strauss 1821) Zenker 1854

Cypris marginata Strauss 1821. Strauss, 1821:59, pl. 1, figs. 20-22.

Cyprois marginata (Strauss 1821) Zenker 1854. Sharpe, 1908:415-416, pl. 58, figs. 1-5; Shelford, 1913:177, 179, 185, fig. 129; Sharpe, 1918:809, figs. 1256a, b, c, d.

Type Locality: Europe.

Description of the Female (chiefly after Klie, 1938a): An ostracod of the genus Cyprois. From the side, shell high in the middle, greatest height about seven-tenths of the length. Anterior margin evenly rounded; the posterior margin flatly rounded; and the ventral margin slightly sinuate. Seen from above, the right shell overlaps the left; the anterior is more pointed than the posterior; and the greatest width which is about

one-half of the length lies in the middle of the shell. Shell measures 1.7 mm. in length.

The penultimate podomere of the antenna narrow, terminal claws slender; swimming setae extending to the tip of the claws. Furcal ramus little curved; dorsal seta modified claw-like and subequal to the terminal claw.

Description of the Male (after Sars, 1928): Shell of male smaller than that of female. Shell similar to that of female except the posterior margin is more rounded. Prehensile palps nearly equal in shape and size. Furcal ramus much more curved in the male than in the female. Length of shell of male about 1.5 mm.

Remarks: Representatives of this species have not been collected by the present writer in Illinois. As a result, it is thought advisable to give only a brief synopsis of the specific description as complete descriptions may be found in both European and American works on ostracods (*vid.* Sharpe, 1908).

Ecology: Both Sharpe (1908) and Shelford (1913) report this species from vernal ponds.

Distribution: Cyprois marginata is found throughout most of the Holarctic region except Asia. Sharpe (1908) and Shelford (1913) found this species in the region of Jackson Park, Chicago, Illinois. Furtos (1933) found this species in Ohio.

SUBFAMILY CYPRIDOPSINAE

Shell from the side, usually high and short (figs. 115, 118); from above, either tumid or compressed. Length of shell not over 1.0 mm. Antenna of five podomeres with swimming setae well developed or reduced. Outer masticatory process with two spine-like setae either toothed or smooth. Distal end of third thoracic leg modified for grasping (fig. 120). Furca reduced to a base ending distally in a long seta or "flagellum" (fig. 117). Reproduction in many species entirely parthenogenetic. The subfamily is cosmopolitan.

KEY TO GENERA OF THE SUBFAMILY CYPRIDOPSINAE IN ILLINOIS

a. Shell tumid, valves nearly equal; ultimate podomere of the maxillary palp cylindrical, longer than wide.....Genus Cypridopsis Brady 1867

b. Shell compressed, right valve higher than the left and extending dorsally above the left; ultimate podomere of the maxillary palp distally wider than long (fig. 119).....Genus Potamocypris Brady 1870

Genus CYPRIDOPSIS Brady 1867

Shell short, high, tumid (fig. 115). Valves differ little, neither projects conspicuously above the other dorsally. Swimming setae of the antenna well developed. Terminal podomere of the maxillary palp cylindrical, not widened distally. The respiratory plate of the first thoracic leg carries two or more setae. Furca greatly reduced, consisting of a base tapering distally to form a long seta or "flagellum" with a second shorter seta attached to the posterior margin close to the distal end of the base (fig. 117). Members of this genus are found in nearly all parts of the world. A single species, *Cypridopsis vidua* (O. F. Müller 1776), known from Illinois.

Cypridopsis vidua (O. F. Müller, 1776) Brady 1867

(Pl. VIII, figs. 115-117)

Cypris vidua O. F. Müller 1776. O. F. Müller, 1776:199.

Cypridopsis vidua (O. F. Müller 1776) Brady 1867. Sharpe, 1897:469-470; Kofoid, 1908:258; Shelford, 1913:152, figs. 81a, b; Sharpe, 1918:807, fig. 1253.

Cypridopsis vidua obesa Furtos 1933 (*non* Brady and Robertson 1869). Furtos, 1933:431.

Cypridopsis pustulosa Furtos 1933. Furtos, 1933:431-432, pl. 6, figs. 5-9.

Type Locality: Europe.

Description of the Female: A species of the genus Cypridopsis. Shell (fig. 115) from the side: ovoid in shape; the greatest height just posterior to the center and about two-thirds of the length. Dorsal margin broadly arched, usually with a definite angulation at the highest point. Ventral margin slightly sinuated in most shells; anterior and posterior margins rounded, the anterior slightly more narrowly rounded than the posterior. The ventral surface is flattened. Seen from above: shell tumid; the greatest width is slightly posterior to the middle and little exceeds the greatest height. The anterior margin of the right valve (fig. 116) with fifteen to twenty tubercles which are inconspicuous in some individuals. The surface of the shell is marked by minute impressions. The surface is hairy. The shell is yellowish white to light green in color and usually is ornamented by four color bands which extend from the dorsal margin down the side of each valve. These bands vary in color from light green to dark green, to black in some individuals. There are usually four bands which are placed as follows: one along the posterior margin of the shell, one near the anterior margin, one immediately behind the eye, and one between the last mentioned and the posterior band. These blotches or bands vary considerably in intensity

and indeed may be too weak to be detected by reflected light. Such bands may be demonstrated on isolated valves by the use of transmitted light.

The swimming setae of the antennae extend beyond the ends of the terminal claws. The respiratory plate of the first thoracic leg bears five setae. The terminal seta or "flagellum" of the furca (fig. 117) about equals twice the length of the base. Average length of the shell is about 0.70 mm.

Male: Unknown. The report of males from middle Europe by Spandl (1925) is doubted by European workers (Klie, 1938a).

Remarks: Cypridopsis vidua is variable in shape, size, and color. The greatest variation is in the color bands, some individuals having dark conspicuous bands, others inconspicuous bands. The apparent absence of color bands has led many investigators to assign individuals to the species *C. obesa* Brady and Robertson 1869. Furtos (1933), for example, assigns certain individuals to *C. vidua obesa* Brady and Robertson 1869 in spite of the fact that she found no anatomical differences between the two forms, *vidua* and *obesa,* as they occur in Ohio. Since there are differences in shell shape and the number of setae on the respiratory plate of the first leg in *vidua* and *obesa* and these differences have been recognized by Sars (1928) and Klie (1938a), it is apparent that Furtos has erred in assigning the Ohio specimens with the anatomical characteristics of *vidua* to the group *obesa.* It is very doubtful if *Cypridopsis obesa* occurs in North America, as all illustrations of American individuals assigned to *obesa* are without doubt indistinctly banded individuals of *vidua.* The writer has found a great variation in color in single population samples; and, indeed, many shells, which appear to be without bands, are seen to have bands when cleared valves are examined by transmitted light.

The variability of the shell is demonstrated by the tubercles along the anterior margin of the right valve. This variation in size and number of tubercles has led to some confusion which has culminated in the creation by Furtos (1933) of a new species, *Cypridopsis pustulosa,* to include individuals which are unbanded and which have tubercles along the anterior margin of the right valve. Although most authors do not mention these tubercles, they are known to occur in *Cypridopsis vidua,* as Klie (1938a) states: "Der V. R. [Vorderrand] der r. Sch. [rechte Schale] weist an der Innenseite eine aus etwa 20 winzigen Höckerchen bestehende Körnelung auf." These tubercles are often inconspicuous but may nearly always be detected even when very minute by an examination under high magnification of isolated right valves which have been deeply stained in acid fuchsin and cleared. There appears to be no correlation between the intensity of the color bands and the prominence of the tu-

bercles. In fact, many shells showing deeply colored blotches distinctive of *vidua* also show pronounced tubercles (which Furtos gives as the chief characteristic of her species *pustulosa*) along the anterior margin of the right valve.

The cause of the variability in color is unknown. It is doubtful if it is the result of the development of populations differing in color. The present writer has noticed that individuals taken in late summer from masses of algae and aquatic vegetation are usually more darkly colored than are specimens taken earlier in the season before the green plants replace the dead vegetation left from the previous year. It is entirely possible that either through the action of additional sunlight or by the ingestion of more green plant material, the pigment may become more highly developed. Such an hypothesis would necessarily require verification experimentally.

Ecology: Cypridopsis vidua is the most common of all the ostracods in Illinois. It was taken by the present writer in 505 of the 713 collections made in Illinois. Not only is it found everywhere, but there are few ostracods which are found in such great numbers of individuals in single collections. It is especially abundant in permanent still waters although it will tolerate considerable current when aquatic vegetation is present as a substratum. It is found only to a limited extent in April and May, and for this reason is not often taken from early vernal ponds. *Cypridopsis vidua* is present in most collections made in June and July regardless of the habitat although they reach their greatest abundance in the algae and aquatic vegetation of permanent lakes, river backwaters, and vernal ponds which do not dry up until late in the serotinal season.

Distribution: This species is common throughout the Holarctic region and has been reported from the Neotropical as well (Klie, 1926a). In every county in Illinois in which the writer made a reasonable sampling, *Cypridopsis vidua* was present.

Genus POTAMOCYPRIS Brady 1870

Shell compressed; the right valve projects much beyond the left dorsally. Valves usually hairy (fig. 118). Swimming setae of the second antenna usually well developed (fig. 118-S); extending to the tips of the terminal claws or beyond. Terminal podomere of the maxillary palp short, distally wider than long, and armed with short claw-like setae (fig. 119). The respiratory plate of the first thoracic leg with not more than two setae.

Only one species, *P. smaragdina* (Vávra 1891), known from Illinois.

Potamocypris smaragdina (Vávra 1891) Daday 1900

(Pl. VIII, figs. 118-124)

Cypridopsis smaragdina Vávra 1891. Vávra, 1891:80-81, fig. 26; Sharpe, 1897:470-471, pl. 48, figs. 11-12.

Potamocypris smaragdina (Vávra 1891) Daday 1900. Sharpe, 1903:992, pl. 65, figs. 5-7; 1918:808, figs. 1254a, b, c.

Potamocypris smaragdina (Vávra 1891) var. *compressa* Furtos 1933. Furtos, 1933: 435-436, pl. 6, figs. 10-14; Dobbin, 1941:231-232, pl. 2, figs. 1-6.

Type Locality: Bohemia.

Description of the Female: A species belonging to the genus Potamocypris. Shell (fig. 118) from the side with a high rounding dorsal margin, giving the shell a three-sided appearance. The greatest height is little more than one-half the length; greatest height behind the eye but anterior to the middle of the dorsal margin. Posterior end pointed and narrower than the anterior. The margins of the two ends merge into the dorsal margin without any interruption. The ventral margin is slightly sinuated. The right valve extends above the left dorsally; the left shell extends beyond the right by its hyaline flange both anteriorly and posteriorly. This flange is confined posteriorly to the posterior-ventral corner and intensifies the acutely pointed appearance; anteriorly it extends from a little below the eye along the anterior margin of the shell and ends near the anterior end of the ventral margin. Considerable variation is shown in the extensiveness of the development of this flange. From above, the shell appears elliptical, bluntly pointed posteriorly, more acutely pointed anteriorly; the greatest width is less than one-half the length and located in front of or near the middle. Surface of shell hirsute; the hairs are stout and almost spine-like, directed posteriorly parallel to each other. They are appressed closely to the shell surface. The valve surfaces are pitted. The color varies but is usually light green or yellowish-green and commonly displays two dorsal lateral blotches of some shade of green. Length and height of valves of several females from Illinois (mounted in diaphane and measured to include the flanges) are as follows:

Right		Left	
Length	*Height*	*Length*	*Height*
0.64 mm.	0.39 mm.	0.66 mm.	0.38 mm.
0.62	0.36	0.64	0.35
0.63	0.37	0.66	0.38
0.56	0.36	0.58	0.36

The swimming setae of the antennae extend beyond the ends of the terminal claws by one-third of their own length which is about equal to the length of the claws. The base of the furca narrows rapidly to form the "flagellum."

Description of the Male: The shell of the male differs somewhat

from the female in size and shape. On the whole, the (fig. 121) shell is much more elongate, the height little more than one-half of the length; the peak of the dorsal margin more attenuated than in the female. The anterior and posterior slopes of the dorsal margin are also more flattened. The ventral margin is conspicuously sinuated; the hyaline margin of the anterior end is well developed. The coloration, sculpturing, and hirsuteness of the shell similar to the female. The testes extend in the form of a whorl to the anterior one-half of the shell (fig. 121-A). The soft parts are like those of the female.

Measurements of the shell halves of several mature males (mounted in diaphane; measurements include the hyaline border or flange (fig. 121-F)) are as follows:

Right		Left	
Length	*Height*	*Length*	*Height*
0.52 mm.	0.28 mm.	0.58 mm.	0.32 mm.
0.52	0.28	0.55	0.29
0.56	0.32	0.61	0.33

The right prehensile palp (fig. 122b) has a long cylindrical propodus with two stout setae near the distal end of the anterior margin; the dactylus is narrow and gently curved. The left prehensile palp (fig. 122a) is larger than the right, the propodus is stout and has two small lateral setae near the distal end of the anterior margin. The dactylus is stout, falciform, and is acutely pointed with a small protuberance near the point. The ductus ejaculatorius (fig. 123) is elongated with thirteen to fifteen rows of chitinous spines. The penis (fig. 124) has a wide base and a single lateral lobe. The lateral lobe is distally bilobed, stout, and extends beyond the blunt end of the base.

Males were present in six of fifty collections selected at random. They appear to be equal in number to the females in the collections in which they occur. There seems to be no correlation between the presence of males and the season or locality in which they occur.

Remarks: Potamocypris smaragdina is extremely variable in size, shape, and color of shell. This variability, along with the mistakes in the original description as given by Vávra (1891), has led to some misconception regarding this species. In assigning Illinois material to *P. smaragdina,* Sharpe (1897) remarks that the eye in Illinois material is below and anterior to the highest point of the shell in contrast to the condition in the type material of which Vávra (1891) wrote: "Die Schale ist fast dreiseitig, im ersten Drittel, über dem durch die Schale durchschimmernden Auge am höchsten." If a straightedge is laid along the dorsal margin parallel to the ventral margin of the shell in Vávra's drawing (1891:81, fig. 26 (1)), it will be found that the highest point

of the shell is distinctly posterior to the eye much as it is in Illinois specimens.

Furtos (1933) seems also to have been led astray by Vávra's incomplete and erroneous description of the type material. She bases the separation of her variety *compressa* from the type of Vávra on two differences: (1) the Ohio form is longer, lower, and narrower than the European, and (2) the swimming setae of the antennae in the Ohio form extends beyond the terminal claws by the length of the claws rather than "beyond the terminal claws by only one-third the length of the claws" (Furtos, 1933) as in the European form. Both of these differences may be obliterated when Vávra's description is properly understood. In the first place, the height, 0.48 mm., given by Vávra (1891) is plainly an error. If the shell figured (Vávra, 1891:fig. 26 (1)) is measured and the height computed from the height-length ratio (assuming the length to be 0.68 mm.) the height will be about 0.38 mm. Thus the height is little more than one-half the length. This is verified by Wagler (1937). The height of the variety *compressa* as given by Furtos then coincides with this computed height for *P. smaragdina* of Europe. The error in the height given in Vávra's work is apparently a typographical error. Such errors are very common in Vávra's work on the ostracods of Bohemia and several others occur in Vávra's description of *P. smaragdina.* Regarding the difference in length of the swimming setae of the antennae as given by Furtos, there has been a misunderstanding in the reading of Vávra's description. From the nature of his sentence structure, it is impossible to tell whether he intended to say that the swimming setae extend beyond the end claws of the antenna by one-third of the length of the setae or one-third of the length of claws, for he (1891) writes: "Von den übrigen Arten [*Cypridopsis villosa*] unterscheidet sie sich hauptsächlich durch die Bildung des zweiten Antennenpaares, dessen am Ende des dritten Gliedes inserirte Schwimmborsten sehr lang sind, so dass sie das Ende der Klauen um ein drittel ihrer Länge überragen." Furtos (1933) took this to mean that the setae extend beyond the claws by one-third of the length of the claws. However, that Vávra meant that the setae extend beyond the end claws by one-third of the length of the setae is supported by Wagler (1937) who writes: "Schwimmbo. [Schwimmborsten] der Ant. [Antenne] überragen die Endkl. [Endklaue] um ⅓ ihrer eigenen Lg. [Länge]." Thus there remains no difference between the var. *compressa* of Furtos and the typical European form except a slightly smaller width in the former. This difference can probably be assigned to individual variation.

Ecology: Potamocypris smaragdina is a common species especially of permanent waters. Only twenty of the one hundred and eighteen collections made by the writer containing this species were from tempo-

rary still and running waters, the others from permanent waters, about one-half from lakes and one-half from streams. The reason for not finding this species in temporary waters may be its seasonal appearance for it seldom becomes abundant before late May when many of the temporary waters have become dry. This species usually reproduces parthenogenetically but a number of males do occur in many collections.

Distribution: This species is found in North America and in Bohemia and Switzerland in Europe. The writer has taken it from all parts of the state of Illinois although it is much more abundant in the northern two-thirds than in the southern one-third of the state.

FAMILY DARWINULIDAE

Surface of shell smooth; hinge without teeth. Antennule composed of six podomeres, with strong spine-like setae. Antenna with a base of two podomeres and an endopodite of three podomeres, also a vestigial exopodite armed with two setae. Swimming setae lacking. Mandible with a short palp of three podomeres; of which the first is wide and has a row of long feathered setae. The respiratory plate of the mandible is small and is armed with short setae. The masticatory processes of the maxilla are short and heavy; the palp has two podomeres, the basal one wide, the distal one small and relatively narrow. The respiratory plate of the maxilla well developed, very large, with numerous large feathered setae. the first thoracic leg with a strong masticatory structure; a leg-like palp of three podomeres, and a circular respiratory plate with numerous setae. The second and third thoracic legs are similar, each composed of five podomeres and adapted for crawling. The furca is completely lacking, the body ending posteriorly in a short, unpaired cone-like projection (fig. 126). The ovaries do not originate in the cavity between the shell plates; the female carries the eggs in the posterior dorsal part of the shell cavity during their development. A single genus is known.

Genus DARWINULA Brady and Norman 1889

With characteristics of the family Darwinulidae.

Of the few species known, only one, *Darwinula stevensoni,* has been reported from North America.

Darwinula stevensoni (Brady and Robertson 1870)
Brady and Norman 1889
(Pl. IX, figs. 125, 126)

Argilloecia (?) *aurea* Brady and Robertson 1870. Brady and Robertson, 1870:16, pl. 8, figs. 4-5.

Polycheles stevensoni Brady and Robertson 1870. Brady and Robertson, 1870:25-26, pl. 7, figs. 1-7; pl. 10, figs. 4-14.

Darwinula stevensoni (Brady and Robertson 1870) Brady and Norman 1889. Brady and Norman, 1889:122-123, pl. 10, figs. 7-13; pl. 13, figs. 1-9; pl. 23, fig. 5.

Darwinula improvisa Turner 1895. Turner, 1895:336-337, pl. 81, figs. 1-3, 13.

Darwinula stevensoni (Brady and Robertson 1870) Brady and Norman 1889. Sharpe, 1918:807, fig. 1252.

Type Locality: British Isles.

Description of Female: An ostracod of the genus Darwinula. From the side, the shell (fig. 125) very narrowly wedge-shaped with the broader end posterior. The greatest height equal to about two-fifths of the length and highest near the middle of the posterior one-half of the shell. The dorsal margin is very flatly arched; the ventral margin is straight. Viewed from above, the shell appears elongate; the greatest width lies at the posterior one-third and is greater than one-third of the length; posterior end rounded, anterior end pointed. The right shell extends beyond the margins of the left both anteriorly and posteriorly. Each of the nine muscle scars are wedge-shaped and together form a rosette in the posterior part of the anterior one-half of the shell. The shell measures about 0.70 mm. in length. The distal podomere of the mandibular palp is several times longer than wide.

Males: The present writer has seen no males of this species. There are no available descriptions of males; the extent of reports in the literature regarding the nature of the male is a single drawing of the penis by Brady and Robertson (1870:pl. 10, fig. 13).

Remarks: G. W. Müller (1912) in "Das Tierreich" lists this species under the designation *D. aurea* (Brady and Robertson 1870). Brady and Robertson described this species twice in the same publication, first under the specific designation *aurea* (1870) and then under *stevensoni* (1870). Since there is no statement in the International Rules of Nomenclature which would require the recognition of the first (according to the pagination) of two names given in a publication, the name *stevensoni* rather than *aurea* should be retained for this species because: (1) in *stevensoni* the description is based on several individuals while the description of *aurea* is based on a single individual; (2) the description and figures of *stevensoni* are more complete than those for *aurea;* (3) the designation *stevensoni* was preferred by Brady in the work by Brady and Norman (1889) and *aurea* is given as a synonym; (4) *stevensoni* is a long established name and is used by most writers.

Ecology: D. stevensoni appears to be an inhabitant chiefly of large lakes. Turner (1895) reported it under the name *D. improvisa* from a sandy bottom reservoir about three miles in circumference. The present writer secured a single individual in material taken from the sandy bottom

of a large lake of glacial origin. That it is not always associated with a sandy bottom is shown by Sars (1928) who found it on a muddy bottom. This species usually reproduces parthenogenetically.

Distribution: D. stevensoni is nearly Holarctic in distribution, having been reported from Europe and North America. In North America, it was reported by Turner (1895) from Atlanta, Georgia. The present writer found a single female in a collection made by Bertrand A. Wright on August 8, 1940 from Hastings Lake near Antioch, Lake County, Illinois.

FAMILY CYTHERIDAE

Shell variable in shape and sculpturing; seldom smooth, usually with reticulations; often with spines, furrows, or tubercles (fig. 127). Valves nearly equal; often tooth-like projections along the hinge (fig. 137-AT, PT). The antennules consist of a base of two podomeres and an endopodite of three or four podomeres. The setae of the antennules are short and stout, often claw-like. The exopodite or the flagellum" (fig. 131-F) of the antenna is represented by a long hollow seta forming a duct carrying the secretion from a gland which is thought to furnish adhesive material used by the animal in crawling over smooth surfaces. The endopodite of the antenna is composed of three podomeres; the long penultimate one may be divided. Swimming setae lacking. Three pairs of thoracic legs similar and all adapted for crawling. Furca always greatly reduced (fig. 138). In the male, the penis is always present and well developed (figs. 134, 141); the ductus ejaculatorius is absent; and a male accessory sense organ consisting of numerous setae on a short base (fig. 135) is located between and somewhat medially to the bases of the first and second pairs of thoracic legs. The gonads do not lie between the plates of the valves but are in the body lateral to the intestine. In some species, the eggs are retained in the shell cavity during development.

The family includes over thirty genera belonging to several subfamilies, most of which are marine. Two subfamilies, Limnocytherinae and Entocytherinae, are known from the fresh-waters of North America.

KEY TO SUBFAMILIES OF THE CYTHERIDAE IN ILLINOIS

a. Free margins of valves flattened, with many long pore-canals (fig. 128-P); shell usually subrectangular, often with protuberances or furrows (fig. 127); the respiratory plate of the mandible well developed; the furca usually with two short setae (fig. 132).....Subfamily LIMNOCYTHERINAE

b. Free margins of the valves without conspicuous pore-canals; shell usually reniform or subelliptical and without furrows or protuberances; respiratory plate of mandible usually reduced to two or three setae; the furca extremely rudimentary.....Subfamily ENTOCYTHERINAE

SUBFAMILY LIMNOCYTHERINAE

Shell weakly calcified. Margin of each valve with many pore-canals (fig. 128-P). Eyes fused. Both antennules and antennae foot-like and adapted for creeping. Exopodite (flagellum) (fig. 131-F) of the antenna well developed in both sexes. Palp of the mandible of three podomeres and with a well developed respiratory plate. Furca small, usually with two short spine-like setae (fig. 138). The members of this subfamily are entirely fresh-water in habitat. A single genus, Limnocythere, is known from Illinois.

Genus LIMNOCYTHERE Brady 1867

Shell thin, usually with either protuberances or furrows (fig. 127-F, P) or both; the free margin edge where the valves meet is extremely wide with long, slender, often branching pore-canals (fig. 127-M). Endopodite of the antennules consist of three podomeres, of which the distal one is four times longer than wide and is armed with four setae of which two are fused at their bases (fig. 130-F). Antenna with three terminal claws; the exopodite (flagellum) is divided into basal and distal portions by an articulation (fig. 131-A). Respiratory plate of the mandible with five long apical and two short lateral setae. The palp of the maxilla has a distinct distal podomere with one of the distal setae claw-like. The thoracic legs are similar and each has two setae on the anterior margin of the proximal podomere (fig. 139). Furca cone-shaped with one terminal seta and one lateral seta (fig. 132). Three species belonging to this genus are known from Illinois.

In the literature there is some confusion regarding the proper spelling of the name of this genus. Some writers as Sharpe (1897) and Sars (1928) give the spelling as "Limnicythere." Most writers, on the other hand, give the spelling as "Limnocythere." The latter is correct. It was used by Brady in a publication dated September, 1867. The spelling wherein an "i" replaces the "o" results from certain writers following a later publication by Brady (1868). The content of this later publication was read before the Linnean Society of London in May, 1866. Since reading a paper does not constitute publication, the more orthographically correct name, Limnocythere, stands as the valid designation for this genus.

KEY TO SPECIES OF THE GENUS LIMNOCYTHERE IN ILLINOIS

1a. Shell with conspicuous, well developed protuberances (fig. 127-P); anterior margin of shell with tubercles (fig. 128-T); dorsal seta of furca arising from a papilla (fig. 132-P) ..... *L. verrucosa sp. nov.*

b. Shell without well developed protuberances (fig. 140); anterior margin of shell without tubercles; dorsal seta of furca arises directly from the base without the intervention of a papilla (fig. 138-D) 2

2a. Shell with two dorsal-lateral furrows (fig. 140); surface sculpturing conspicuous; furca blunt, with one of the setae at the distal end (fig. 138) .....*L. reticulata* Sharpe 1897

b. Shell with one dorsal-lateral furrow; surface sculpturing inconspicuous; furca with base tapering to an acute point and both of the setae well removed from the distal end.....*L. illinoisensis* Sharpe 1897

Limnocythere verrucosa sp. nov.

(Pl. IX, figs. 127-135)

Type Locality: West Loon Lake, Lake County, Illinois.

Description of the Female: A species of the genus Limnocythere. From the side: shell (fig. 127) subrectangular; height slightly more than one-half the length; dorsal margin straight; ventral margin well sinuated near the center; anterior margin evenly rounded with a very wide hyaline border; posterior margin with an angulation near the center. Teeth of the hinge weak. Four oval muscle scars with the longitudinal axis of each scar parallel to the dorsal margin of the shell (fig. 127-S); the four scars forming a row with the axis of the row at right angles to the axis of each individual scar. The scars are subcentrally placed. The shell bears laterally and dorsally in the anterior one-half two furrows (fig. 127-F). These are similar to the furrows in *L. reticulata.* Near the furrows there are two large, rounded protuberances. One of these is anterior and ventral to the anterior furrow; the other is posterior and slightly ventral to the posterior furrow. A third large protuberance is located very near the ventral margin of each valve just posterior of the deepest portion of the sinuation. The flattened, hyaline border (fig. 128) of the shell contains numerous pore-canals near the outer ends of which originate large setae. Between these setae the outer margin is plumose, the hairs being closely placed and delicate. The anterior margin also has eight to twelve small tubercles along its edge. The entire shell including the hyaline borders is sculptured with small raised areas giving the shell a reticulated appearance. From above, the shell (fig. 129) appears moderately inflated as a result of the protuberances. The width is nearly equal to the height, being but slightly more than one-half of the length.

The length and height of several right valves are as follows (mounted in diaphane; measurement includes the hyaline border):

Length	*Height*
0.55 mm.	0.30 mm. (holotype)
0.56	0.30
0.54	0.30
0.60	0.30

The antennules are stout; the length of the ultimate podomere is five and one-half to six times the width. The two subdistal claws are

relatively short, subequal or equal to the ultimate podomere, and the tips are on a level with the point of fusion of the two terminal setae. The two terminal setae (fig. 130-F) are fused basally for a distance equal to the length of the terminal podomere of the appendage. Of the unfused ends of these two setae, the more slender one has a free portion which is three times the length of the unfused portion of the stouter of the pair. The "flagellum" (fig. 131-F) of the antenna reaches somewhat past the center of the longest terminal claw. The terminal claws of the thoracic legs are relatively short in comparison to those of most Limnocythere; the claw of the first leg is equal to the sum of the last two podomeres of the appendage; the claw of the second leg is about one and one-third times the sum of the lengths of the last two podomeres; and the claw of the third thoracic leg has a length little more than the sum of the distal three podomeres.

The furca (fig. 132) is peculiar in having a trilobed base; the middle lobe is conical with a small needle-like seta on the blunt apex; the posterior lobe (fig. 132-P) is small, papilla-like, and bears a long seta which reaches to the distal end of the terminal lobe.

Description of the Male: The shell (fig. 133) of the male differs from that of the female in being slightly longer and not relatively as high and by having the protuberances greatly reduced. The shell is prominently inflated directly above the ventral sinuation. The length and height of the right valves of two male shells are as follows (mounted in diaphane; the margins included in the measurements):

Length	*Height*
0.59 mm.	0.28 mm.
0.62	0.27

In the male, the sculpturing of the shell and the nature of the margins are similar to those of the female. The appendages also differ little from those of the female. The ultimate podomere of the antennule is slightly more slender, and the "flagellum" of the antenna reaches nearly to the tips of the end claws. The terminal claw of the third leg is equal at least to seven-eighths of the length of the rest of the leg.

The base of the penis (fig. 134) has an irregularly curved anterior margin. There are several appendages. One is L-shaped and is directed posteriorly; a second large appendage passes along the base of the penis and is directed anteriorly along the outside. It extends slightly beyond the base anteriorly. Other smaller appendages and chitinous supporting rods are present. The furca is very different from that of the female but such differences are not unusual in species of this genus. The furca is a tapering cone, very long and bearing two setae, one near the base and another near the sharply pointed tip. The furca looks much like that of *L. illinoisensis* Sharpe 1897 (Sharpe, 1897:pl. 39, fig. 12).

Remarks: Limnocythere verrucosa sp. nov. is markedly different from other Illinois species of Limnocythere. The most readily available criterion for recognition is the peculiar inflated condition of the shell caused by the bulging protuberances. The furca of the female differs from all other species of Limnocythere by having the posterior seta elevated on a papilla.

Ecology: This species has been taken only from permanent lakes in which there is an abundance of aquatic vegetation or alga.

Distribution: L. verrucosa was collected for the writer by Bertrand A. Wright from West Loon Lake, Lake County, Illinois, on August 7, 1940. No other records are known.

The holotype (female) and allotype (male) of this species are deposited in the U. S. National Museum (Cat. Nos. 81085 and 81086). Paratypes of both sexes are in the collections of Dr. H. J. Van Cleave and the writer.

Limnocythere reticulata Sharpe 1897

(Pl. IX, fig. 136-141)

Limnicythere reticulata Sharpe 1897. Sharpe, 1897:423-425, pl. 39, figs. 1-7; 1918: 806, figs. 1250a, b, c.

non Limnocythere reticulata Procter 1933. Procter, 1933:231, figs. 39a-d.

Type Locality: Urbana, Illinois.

Description of the Female: An ostracod of the genus Limnocythere. From the side, shell (fig. 136) appears subrectangular; dorsal margin straight; ventral margin with a sinuation; anterior and posterior margins evenly rounded. The height is but little more than one-half of the length. From above, the shell is elliptical with the sides slightly flattened and the anterior end narrowly and acutely pointed. The greatest width is little more than one-third of the length and lies posterior to the middle of the shell. Each valve has two lateral furrows in the vicinity of the eye. The surface is sculptured with a network of polygonal reticulations which cover the surface except in the region of the eye. The four muscle scars are arranged in a transverse row; each scar is elliptical in shape and lies with its long axis parallel to the longitudinal axis of the other scars and to the dorsal margin of the shell. The length of the shell is 0.65 to 0.70 mm. Length and height of right valves of several female shells from Illinois are given as follows (mounted in diaphane and measured to include the hyaline border):

Length	*Height*
0.66 mm.	0.36 mm.
0.68	0.38
0.63	0.32
0.70	0.36

The antennules have a narrow ultimate podomere about seven times as long as wide and are armed distally with four setae, two of which have their bases fused. Of these two, one has the free portion about twice as long as the free portion of the other. The antenna has three terminal spines, the two longer ones are equal and have a length equivalent to four times the length of the ultimate podomere. The third claw measures about seven-eighths the length of the longer ones. The terminal claw of the first thoracic leg is a little longer than the sum of the lengths of the last two podomeres; terminal claw of the third leg very long, equal to the sum of the last three and one-half podomeres. The furca (fig. 138) is described by Sharpe (1897) as follows: "Rudimentary caudal rami cylindrical, thick, blunt, about three times as long as wide, with a small seta near base, not over two thirds as long as the width of the ramus, and a stouter one near the tip of the ramus, twice as long as the preceding one."

Description of the Male: The shell (fig. 140) of the male differs considerably from the female by being longer, relatively less high, and with the posterior end more narrowly rounded and obtusely pointed. Measurements of the right valves (borders included) of the shells of several males from Illinois are as follows (mounted in diaphane):

Length	*Height*
0.74 mm.	0.34 mm.
0.76	0.38
0.78	0.40
0.72	0.36

The appendages are similar to those of the female except that the terminal setae of the third leg (fig. 139) is much longer, the length being equal at least to the length of the rest of the leg. The penis (fig. 141) is large; the anterior margin is irregularly rounded; the base ends bluntly in a point. Several appendages are present of which the largest is falciform and extends posteriorly beyond the base.

Remarks: This species is readily distinguishable from other Illinois species of Limnocythere by its reticulated shell surface and its lack of protuberances. The blunt, short furca with the terminal seta near the rounded distal end is an important diagnostic characteristic.

The record of this species by Procter (1933) from Lake Wood on Mount Desert Island, Maine, appears to be based on an erroneous specific determination. The shell pictured (Procter, 1933:figs. 39a, b) is certainly not the *reticulata* of Sharpe since it is too elongate and the dorsal margin is not straight. Likewise the illustration of the penis (his fig. 39d) lacks the prominent appendage characteristic of the penis of *L. reticulata* Sharpe.

Ecology: Limnocythere reticulata is a species from running waters although it may be found on occasion in temporary pools. It is seldom found in permanent lakes. It tolerates all conditions of current in streams since it does not swim but creeps along the bottom or over the vegetation. In the writer's seventy collections of this species, all were taken in May and June except one in July and one in August.

Distribution: Limnocythere reticulata is known only from Illinois. Sharpe (1897) collected the type material from a pond near Urbana, Champaign County, Illinois. The present writer has taken this species from twenty-five counties scattered chiefly over the central and southern parts of the state.

Limnocythere illinoisensis Sharpe 1897

Limnicythere illinoisensis Sharpe 1897. Sharpe, 1897:425-428, pl. 39, figs. 8-13; pl. 40, figs. 1-6; Kofoid, 1908:258; Sharpe, 1918:807, figs. 1251a, b, c, d, e.

Type Locality: Havana, Illinois.

Description of the Female (after Sharpe, 1897): A species of the genus Limnocythere. From the side, subelliptical with dorsal margin straight, both ends evenly rounded, and the ventral margin with a deep sinuation at the anterior one-third just below the muscle scars. The greatest height of the shell is less than one-half of the length; the posterior part of the shell has a greater height than the anterior part. From above, the shell is pointed anteriorly; convex posteriorly; the sides are nearly parallel and straight. There is a single lateral furrow; the shell reticulations are faint. The dimensions of the shell as given by Sharpe are: length, 0.88 mm.; height, 0.40 mm.; width, 0.29 mm.

The terminal podomere of the antennule is four times as long as wide. Terminal claw of second leg is nearly equal in length to the sum of the lengths of the distal three podomeres of the appendage. "Rudimentary caudal rami cylindrical, six to seven times as long as wide, gradually tapering to a seta-like extremity which is five sevenths as long as the main part of the ramus. Two dorsal setae: one situated about the width of the ramus from base and as long as the width of the ramus; the other just anterior to the seta-like termination, and about the same length as the first" (Sharpe, 1897).

Description of the Male (after Sharpe, 1897): The male is much like the female except for details of some of the appendages. The ultimate podomere of the antennule is five times as long as wide, the terminal claw of the antenna has three or four strong teeth near the tip. The claw of the second leg has two or three accessory teeth near the tip; the claw of the third leg is very long, as long as the lengths of the podomeres of the leg united. This claw has cross-striations on the distal one-half.

Sharpe gives no verbal description of the male copulatory organs and it is impossible to describe them adequately from his figure (Sharpe, 1897:pl. 40, fig. 2).

Remarks: The present writer has not observed individuals of this species in any of his collections.

Ecology: Sharpe's specimens were from lakes connected with the Illinois River. Here the bottom was sandy. His collection of type material was in May. Kofoid (1908) found this species during the months of March, August, and November.

Distribution: The only known records of this species are those of Sharpe (1897) and Kofoid (1908) regarding material taken mostly from the Illinois River and connected lakes near Havana, Illinois.

SUBFAMILY ENTOCYTHERINAE

The subfamily Entocytherinae is represented in Illinois by two species of the genus Entocythere, *E. illinoisensis* Hoff 1942 and *E. copiosa* Hoff 1942. For descriptions of these two species, the reader is referred to the writer's recent review of the subfamily Entocytherinae (Hoff, 1942).

SUMMARY

(1) The ostracods of Illinois, and the entire United States as well, have received relatively little attention. Sharpe (1897, 1903, 1908, 1910) investigated the ostracod fauna of Illinois but his work is relatively incomplete since he confined his collecting of material chiefly to Champaign, Mason, and Cook Counties. He gives little comprehensive information on the ecology of the group in any of his publications.

(2) During the course of this investigation, the present writer traveled nearly five thousand miles in the spring and summer of 1940. Over seven hundred collections of ostracods were made from sixty-six counties of the state. At the time of making each collection, the available ecological data were recorded for future analysis.

(3) The writer found that the ostracod species of Illinois may be separated into four groups according to habitat: (a) temporary running waters as vernal streams; (b) temporary still waters as vernal ponds; (c) permanent still waters as large lakes and the backwaters of rivers; and (d) permanent running waters. While many species are typically found in one of these four habitats, others fall into more than one group.

(4) An attempt was made to analyze the field data to find what factors control the habitat range and distribution of ostracod species. It was found that distribution is not correlated with the type of bottom but that there is a distinct relationship between the amount of current in a habitat and the presence of certain species of ostracods. The hydrogen ion concentration apparently has some effect upon distribution by inhibiting certain species from extending their range to the southern part of the state where the waters are often acid. Two species of Cypria are able to tolerate acid conditions.

(5) Ostracods do not enter into immutable association either with other species of ostracods or species of plants found in the habitat. In studying lakes, it is found that the same species of ostracods may be found in all parts of a lake regardless of the kind of vegetation.

(6) Reproduction is both parthenogenetic and syngamic in some species of ostracods, in other species one or the other of the types of reproduction may predominate in varying degree. A list is given showing the kind of reproduction in Illinois species as indicated by the relative abundance of males.

(7) A short summary is given of the distribution of species of ostracods living in Illinois both in relation to world-wide and state range. Seventeen species are reported for the first time from Illinois. One family, Darwinulidae, represented by a single species is reported for the first time from the state.

(8) A complete discussion is given of the external morphology of the

fresh-water ostracods as an aid to future study and specific determination. A summary is given of the morphology of various physiological systems.

(9) A discussion is given of the larger categories in the classification of the order Ostracoda with a comparison of the systems devised by various authors.

(10) In the systematic portion of the thesis, descriptions are given of the thirty-nine free-living ostracod species reported from Illinois. Of these, eleven are reported as being new to the literature. Of these new species, ten belong to the family Cypridae and one belongs to the family Cytheridae.

(11) Keys are given as an aid in the determination to species of the free-living ostracods known to occur in Illinois.

BIBLIOGRAPHY

The following bibliographical list contains all the known references to the ostracods of Illinois and in addition most publications relative to the fresh-water Ostracoda of North America. Literature concerned with ostracods exotic to North America is usually cited only when reference is made thereto in the text.

Publications indicated by the asterisk (*) have not been reviewed by the writer. All of these are early writings which have little taxonomic significance except as the descriptions have been expanded and completed by more recent workers.

Allen, S. A.

1933. Parasites and commensals of North Carolina crayfishes. J. Elisha Mitch. Sci. Soc., 49:119-121.

Alm, Gunnar

1914. Beiträge zur Kenntnis der nördlichen und arktischen Ostracodenfauna. Ark. Zool., 9(5):1-20.

1916. Monographie der Schwedischen Süsswasser-Ostracoden nebst systematischen Besprechungen der Tribus Podocopa. Zool. Bidr. Uppsala, 4:1-248.

Bergold, Alfred

1910. Beiträge zur Kenntnis des innern Baues der Süsswasserostracoden. Zool. Jb. Anat., 30:1-42.

Bernecker, A.

1909. Zur Histologie der Respirationsorgane bei Crustaceen. Zool. Jb. Anat., 27:583-630.

Blake, Charles H.

1931. Two freshwater ostracods from North America. Bull. Mus. Comp. Zool. Harvard, 72:279-292.

Brady, G. S.

*1864. On species of Ostracoda new to Britain. Ann. Mag. Nat. Hist., Ser. III, 13:59-64.

1867. A synopsis of the recent British Ostracoda. Intell. Observ., 12:110-130.

1868. A monograph of the recent British Ostracoda. Trans. Linn. Soc. London, 26:353-495.

*1870. Notes on Entomostraca taken chiefly in the Northumberland and Durham District. Nat. Hist. Trans. Northumb., 3:361-373.

1885. Notes on Entomostraca collected by Mr. A. Haly in Ceylon. J. Linn. Soc. London, 19:293-317.

Brady, G. S., and Norman, A. M.

1889. Monograph of the marine and freshwater Ostracoda of the North Atlantic and of North-western Europe. 1. Podocopa. Trans. R. Dublin Soc., Ser. II, 4:61-270.

Brady, G. S., and Robertson, D.

1870. The Ostracoda and Foraminifera of tidal rivers. Ann. Mag. Nat. Hist., Ser. IV, 6:1-33.

Brehm, V.

1932. Vorläufige Mitteilungen über die Süsswasserfauna Neuseelands. Zool. Anz., 99:79-81.

1939. Zur Entomostrakenfauna der südlichen Halbkugel. Zool. Anz., 126:33-40.

Brues, Charles T.

1932. Further studies on the fauna of North American hot springs. Proc. Amer. Ac. Sci. Boston, 67:185-303.

Chambers, V. T.

1877. New Entomostraca from Colorado. Bull. U. S. Geol. Geog. Sur. Terr., 3:151-155.

Claus, C.

1872. Beiträge zur Kenntniss der Ostracoden, I. Entwicklungsgeschichte von Cypris. Schr. Ges. Naturw. Marburg, 9:151-166. (Also published separately in 1868).

1892. Beiträge zur Kenntniss der Süsswasser-Ostracoden, I. Arb. zool. Inst. Wien, 10:147-216.
1895. Beiträge zur Kenntniss der Süsswasser-Ostracoden, II. Arb. zool. Inst. Wien, 11:17-48.

Cockerell, T. D. A.
1912. The fauna of Boulder County, Colorado, II. Univ. Colorado Stud., 9:41-52.

Creaser, Edwin P.
1931. Some cohabitants of burrowing crawfish. Ecology, 12:243-244.

Cushman, Joseph A.
1905. A new ostracod from Nantucket. Amer. Natural., 39:791-793.
1907. Ostracoda from southeastern Massachusetts. Amer. Natural., 41:35-39.
1908. Fresh-water crustacea from Labrador and Newfoundland. Proc. U. S. Mus., 33:705-714.

Daday, E. von
*1900. Ostracoda Hungariae. Budapest.
1905. Untersuchungen über die Süsswasser-Mikrofauna Paraguays. Zoologica (Stuttgart), 44:1-374.

Dana, James D.
1852. United States Exploring Expedition during the years 1837-1842 under the command of Ch. Wilkes. Vol. 13. Crustacea. Part 2. Cypridae. Philadelphia.

Dobbin, Catherine N.
1941. Fresh-water Ostracoda from Washington and other western localities. Univ. Wash. Pub. Biology, 4:174-246.

Dodds, Gideon S.
1908. A list of the Entomostraca of Colorado. Univ. Colorado Stud., 5:243-250.

Eddy, Samuel
1934. A study of fresh-water plankton communities. Illinois Biol. Mono., 12(4):1-93.

Fassbinder, K.
1912. Beiträge zur Kenntnis der Süsswasserostracoden. Zool. Jb. Anat., 32: 533-576.

Fischer, S.
*1851. Über das Genus Cypris und dessen bei Petersburg vorkommende Arten. Mem. savants sci. St. Petersbourg, 7:127-167.
1855. Beitrag zur Kenntniss der Ostracoden. Abh. der Akad. Munchen Mathem.-Physikal. Cl., 7:637-666.

Forbes, S. A.
1888. Studies of the food of fresh-water fishes. Bull. Illinois Lab. Nat. Hist., 2:433-538.
1893. A preliminary report on the aquatic invertebrate fauna of the Yellowstone National Park, Wyoming, and of the Flathead Region of Montana. Bull. U. S. Fish Comm. 1891, 11:207-258.

Fowler, Henry W.
1912. The Crustacea of New Jersey. Ann. Rep. New Jersey Mus., 1911:29-651.

Furtos, Norma C.
1933. The Ostracoda of Ohio. Ohio Biol. Sur., 5:411-524.
1935. Fresh-water Ostracoda from Massachusetts. J. Washington Ac. Sci., 25:530-544.
1936a. Fresh-water Ostracoda from Florida and North Carolina. Amer. Mid. Natural., 17:491-522.
1936b. On the ostracods from the Cenotes of Yucatan and vicinity. Carnegie Inst. Washington, pub. no. 457:89-115.

Galtsoff, Paul S.
1937. General methods of collecting, maintaining, and rearing marine invertebrates in the laboratory. Culture methods for invertebrate animals. Comstock Publishing Co., Ithaca, N. Y. Pages 5-40.

HALDEMAN, S. S.
1841. (Descriptions of new Cypris species). Proc. Ac. Nat. Sci. Philad., 1:53.
1842a. (Descriptions of new Cypris species). Proc. Ac. Nat. Sci. Philad., 1:166.
1842b. (Description of a new Cypris species). Proc. Ac. Nat. Sci. Philad., 1:184.

HANSTRÖM, B.
1924. Beitrag zur Kenntnis des zentralen Nervensystems der Ostracoden und Copepoden. Zool. Anz., 61:31-38.

HERRICK, C. L.
1879. Microscopic Entomostraca. Ann. Rep. Geol. Nat. Hist. Sur. Minnesota, 7:81-123.
1882. On Notodromas and Cambarus. Ann. Rep. Geol. Nat. Hist. Sur. Minnesota, 10:252-254.
1887. Contribution to the fauna of the Gulf of Mexico and the South. Mem. Denison Sci. Assoc., 1(1):1-56.

HIRSCHMANN, N.
1912. Beitrag zur Kenntnis der Ostrakodenfauna des Finnischen Meerbusens. Acta Soc. Fauna Flora Fennica, 36(2):1-66.

HOFF, C. CLAYTON
1942. The subfamily Entocytherinae, a new subfamily of fresh-water Cytherid Ostracoda, with descriptions of two new species of the genus Entocythere. Amer. Mid. Nat., 27:63-73.

JOHANSEN, FRITZ
1921. The larger freshwater crustacea from Canada and Alaska. Canad. Field-Natural., 35:88-94.

JURINE, LOUIS
*1820. Historie des Monocles, qui se trouvent aux environs de Genève. Genève.

KAUFMANN, A.
1900a. Cypriden und Darwinuliden der Schweiz. Rev. Suisse Zool., 8:209-423.
1900b. Zur Systematik der Cypriden. Mitt. naturf. Ges. Bern, 103-109.

KIEFER, F., and KLIE, W.
1927. Zur Kenntnis der Entomostraken von Brunnengewässern. Zool. Anz., 71:5-14.

KLIE, W.
1925. Muschelkrebse als Baumhöhlenbewohner. Arch. Hydrobiol., 15:509-511.
1926a. Ostracoda. Biologie der Tiere Deutschlands, 22:1-56.
1926b. Über eine neue Art der Ostracodengattung Candona. Zool. Anz., 66:302-306.
1930. Ostracoden aus dem paraguayischen Teile des Gran-Chaco. Arch. Hydrobiol., 22:221-258.
1931a. Campagne spéologique de C. Bolivar et R. Jeannel dans l'Amérique du Nord (1928). 3. Crustacés Ostracodes. Arch. Zool. exp. gén., 71:333-344.
1931b. Zwei neue Arten der Ostracoden-Gattung Candona aus unterirdischen Gewässern im südöstlichen Europa. Zool. Anz., 96:161-168.
1934. Zwei neue subterrane Ostracoden der Gattung Candona. Zool. Anz., 106:193-199.
1935. Drei neue Höhlenostracoden aus der Umgebung von Laibach. Zool. Anz., 111:189-198.
1936. Neue Candoninae aus dem Grundwasser von Belgien. Bull. Mus. Hist. nat. Belg., 12(13):1-13.
1938a. Ostracoda, Muschelkrebse. Die Tierwelt Deutschlands und der Angrenzenden Meeresteile, etc., 34:i-iv, 1-230.
1938b. Ostracoden aus unterirdischen Gewässern in Süditalien. Zool. Anz., 123:148-155.
1938c. *Candona bilobata,* ein neuen Muschelkrebs aus dem Grundwasser der unteren Mainteles. Zool. Anz., 124:216-220.
1938d. Ostracoden aus dem Grundwasser der oberrheinischen Tiefebene. Arch. Naturg., new series, 7:1-28.

Klugh, A. B.
1927. The ecology, food-relations and culture of fresh-water Entomostraca. Trans. R. Canad. Inst., 16:15-99.

Koch, C. L.
*1837-1841. Deutschlands Crustaceen, Myriopoden und Archniden. Heft 10, 11, 12 (1837); Heft 21 (1838); Heft 36 (1841).

Kofoid, C. A.
1908. Plankton studies. V. The plankton of the Illinois River, 1894-1899. Part II. Constituent organisms and their seasonal distribution. Bull. Illinois Lab. Nat. Hist., 8:1-361.

Lilljeborg (Liljeborg), Wilh.
1853. De Crustaceis ex ordinibus tribus: Cladocera, Ostracoda et Copepoda, in Scania occurrentibus. Lund. i-xv, 1-223.

Marshall, W. S.
1903. *Entocythere cambaria nov. gen. et nov. spec.*, a parasitic ostracod. Trans. Wisconsin Ac. Sci., 14:117-144.

Müller, G. W.
1900. Deutschlands Süsswasser-Ostracoden. Zoologica (Stuttgart), 30:1-112.
1912. Ostracoda. Das Tierreich, 31:i-xxxiii, 1-434. (Complete consideration of all literature prior to Dec. 31, 1908).
1927. Ostracoda. Kükenthal-Krumbach Handbuch der Zoologie, 3(1):399-434.

Müller, O. F.
*1776. Zool. Danicae Prodromus. Havniae.
*1785. Entomostraca seu Insecta testacea, quae in aquis Daniae et Norvegiae reperit, descripsit et iconibus illustravit. Lipsiae et Hawniae.

Müller-Calé, K.
1913. Über die Entwicklung von *Cypris incongruens*. Zool. Jb. Anat., 36:113-170.

Needham, James G., and Lloyd, J. T.
1930. The life of inland waters. Thomas, Springfield, Illinois. 1-438.

Needham, P. R.
1938. Trout streams. Comstock, Ithaca. i-x, 1-233.

Nordqvist, O.
1885. Beitrag zur Kenntniss der inneren männlichen Geschlechtsorgane der Cypriden. Acta Soc. Sci. Fenn., 15:1-41.

Nowikoff, M.
1908. Über den Bau des Medianauges der Ostracoden. Z. wiss. Zool., 91:81-92.

Pearse, A. S.
1910. A preliminary list of the crustacea of Michigan. Rep. Michigan Ac. Sci., 12:68-76.
1914. Report on the crustacea collected by the Walker-Newcomb Expedition in Northeastern Nevada in 1912. Occ. Pap. Mus. Michigan, 3:1-4.

Procter, William
1933. Biological survey of the Mount Desert Region. Pt. V. Marine fauna. Wistar Institute of Anatomy and Biology, Philadelphia. 1-402.

Ramdohr, K. A.
*1808. Über die Gattung Cypris Müll. und drei zu derselben gehörige neue Arten. Mag. Ges. Fr. Berlin, 2:83-93.

Rawson, Donald S.
1928. Preliminary studies of the bottom fauna of Lake Simcoe, Ontario. Univ. Toronto Stud. Biol., 31:75-102.
1930. The bottom fauna of Lake Simcoe and its role in the ecology of the lake. Univ. Toronto Stud. Biol., 34:1-183.

SARS, G. O.
1890. Oversigt af Norges Crustaceer, med foreløbige Bamærkninger over de nye eller nimdre bekjendte Arter. Forh. Selsk. Christian., (1):1-80.
1895. On some South-African Entomostraca raised from dried mud. Christian. Selsk. Skr. I. Math.-nat. Kl., (8):1-56.
1896. On some West Australian Entomostraca raised from dried sand. Arch. Math. Naturv., 19(1):1-35.
1901. Contributions to the knowledge of the fresh-water Entomostraca of South America as shown by hatching from dried material. Arch. Math. Naturv., 24(1):1-52.
1926. Freshwater Ostracoda from Canada and Alaska. Report of the Canadian Arctic Expedition, 1913-1918, 7(1):1-22.
1928. An account of the Crustacea of Norway. Bergen, 9:i-xii, 1-277.

SCHLEIP, W.
1909. Vergleichende Untersuchung der Eireifung bei parthenogenetisch und bei geschlechtlich sich fortpflanzenden Ostracoden. Arch. Zellforsch., 2:390-431.

SCHMALZ, J.
1912. Zur Kenntnis der Spermatogenese der Ostracoden. Arch. Zellforsch., 8:407-441.

SCHREIBER, E.
1922. Beiträge zur Kenntnis der Morphologie, Entwicklung und Lebensweise der Süsswasser-Ostracoden. Zool. Jb. Anat., 43:485-538.

SHANTZ, H. L.
1907. A biological study of the lakes of the Pike's Peak region—preliminary report. Trans. Amer. Micr. Soc., 27:75-97.

SHARPE, R. W.
1897. Contribution to a knowledge of the North American fresh-water Ostracoda included in the families Cytheridae and Cyprididae. Bull. Illinois Lab. Nat. Hist., 4:414-482.
1903. Report on the fresh-water Ostracoda of the United States National Museum, including a revision of the subfamilies and genera of the family Cyprididae. Proc. U. S. Mus., 26:969-1001.
1908. Further report on the Ostracoda of the United States National Museum. Proc. U. S. Mus., 35:399-430.
1910. On some Ostracoda, mostly new, in the collection of the United States National Museum. Proc. U. S. Mus., 38:335-341.
1918. The Ostracoda. Ward and Whipple: Fresh-water Biology, 790-827.

SHELFORD, V. E.
1913. Animal communities in temperate America. University of Chicago Press. i-xiii, 1-368. (Second impression, 1937).

SKOGSBERG, TAGE
1920. Studies on marine Ostracods. Part I. Cypridinids, Halocyprids and Polycopids. Zool. Bidr. Uppsala, suppl., 1:1-784.

SPANDL, HERMAN
1925. Die Tierwelt vorübergehenden Gewässer Mitteleuropas. Arch. Hydrobiol., 16:74-132.

STORCH, O.
1926. Über den Fangapparat eines Ostrakoden. Verh. Dtsch. Zool. Ges., 2nd suppl., 80-85.
1933. Morphologie und Physiologie des Fangapparates eines Ostrakoden (*Notodromas monacha*). I, II, and III. Biol. Gen., 9(1):151-198; 355-394; (2):299-330.

STRAUSS, HERCULE E.
*1821. Mémoire sur les Cypris de la classe des Crustacés. Mem. Mus. Hist. nat., 7:33-61.

Turner, C. H.
1892. Notes upon the Cladocera, Copepoda, Ostracoda and Rotifera of Cincinnati, with descriptions of new species. Bull. Sci. Lab. Denison Univ., 6:57-74.
1893. Additional notes on the Cladocera and Ostracoda of Cincinnati, Ohio. Bull. Sci. Lab. Denison Univ., 8(1):1-18.
1894. Notes on American Ostracoda, with descriptions of new species. Bull. Sci. Lab. Denison Univ., 8(2):13-26.
1895. Fresh-water Ostracoda of the United States. Second Rep. State Zool. Minnesota, 1895:277-337. (Contains a very extensive bibliography).
1896. Morphology of the nervous system of Cypris. J. Comp. Neurol., 6:20-44.
1899a. A male *Erpetocypris barbatus* Forbes. Zool. Bull., Boston, 2:199-202.
1899b. Synopsis of North-American invertebrates. V. Fresh-water Ostracoda. Amer. Natural., 33:877-888.

Underwood, Lucien M.
1886. List of the described species of fresh water crustacea from America, north of Mexico. Bull. Illinois Lab. Nat. Hist., 2:323-386.

Vávra, V.
1891. Monographie der Ostracoden Böhmens. Arch. naturw. Landesdf. Böhmen, 8(3):i-iv, 1-116. (Contains a comprehensive bibliography).
1897. Die Süsswasser-Ostracoden Deutsch-Ost-Africas. Tierwelt Deutsch-Ostafrica. Wiss. Forsch. über Land und Leute uns. Ost-Afrik, 4:1-28.

Wagler, Erich
1937. Crustacea. Die Tierwelt Mitteleuropas, 2(2a):1-224.

Ward, Helen L.
1940. Studies on the life history of *Neoechinorhynchus cylindratus* (Van Cleave, 1913) (Acanthocephala). Trans. Amer. Micr. Soc., 59:327-347.

Weckel, Ada L.
1914. Free-swimming fresh-water Entomostraca of North America. Trans. Amer. Micr. Soc., 33:164-203.

Weismann, August
1880. Parthenogenese bei den Ostracoden. Zool. Anz., 3:82-84.

Welch, Paul S.
1935. Limnology. McGraw-Hill, New York. i-xiv, 1-471.

Williams, Leonard W.
1907. A list of the Rhode Island Copepoda, Phyllopoda, and Ostracoda with new species of Copepoda. 37th Ann. Rep. Comm. Fish. Rhode Island (special paper no. 30), 69-79.

Wohlgemuth, R.
1914. Beobachtungen und Untersuchungen über die Biologie der Süsswasserostracoden; ihr Vorkommen in Sachsen und Böhmen, ihre Lebensweise und ihre Fortpflanzung. Int. Rev. Hydrobiol., Biol. Supp., 6:1-72.

Wolf, J. P.
1919. Die Ostracoden der Umgebung von Basel. Arch. Naturg., Abt. A, 85(3):1-100.

Woltereck, R.
1898. Zur Bildung und Entwicklung des Ostrakoden-Eies. Z. wiss. Zool., 64:596-623.

Zaddach, E. G.
1844. Synopseos Crustaceorum Prussicorum Prodromus. Dissertatio zoologica. Regiomonti (Königsberg).

Zenker, W.
1854. Monographie der Ostracoden. Arch. Naturg., 20(1):1-87.

EXPLANATION OF PLATES

All drawings are from material collected in Illinois. A camera lucida was used in every instance and, unless otherwise indicated, all drawings are made from material mounted in diaphane and examined by transmitted light.

PLATE I

Cypricercus reticulatus (Zaddach 1844) Sars 1928; female.

FIG. 1.—Animal with the left valve removed to show the appendages of the left side *in situ*. Scale: 0.5 mm.

AN—Antenna
AU—Antennule
E—Eye
F—Furca
FB—Food balls
G—Female genital lobe
M—Mandible
N—Natatory or swimming setae of antennule
P—Palp of mandible
SH—Edge of right valve
S—Sensory organ of antenna
X—Maxilla
R—First thoracic leg
L—Second thoracic leg
T—Third thoracic leg
V—Natatory or swimming setae of antenna

Candona punctata Furtos 1933; female.

FIG. 2.—Outside view of the right valve. Scale: 0.5 mm.
FIG. 3.—Second thoracic leg. Scale: 0.1 mm. E—End claw. S—Second podomere.
FIG. 4.—Third thoracic leg. Scale: 0.1 mm. C—Shorter companion distal seta of the similarly directed pair. P—Third or penultimate podomere.
FIG. 5.—Furca and genital lobe. Scale: 0.1 mm. D—Dorsal seta. G—Genital lobe.

Candona fluviatilis sp. nov.; female.

FIG. 6.—View from inside of right valve. Scale: 0.25 mm.
FIG. 7.—Shell sculpturing and muscle scars. M—Muscle scars (isolated ones not indicated by letter). S—Sculpturing.
FIG. 8.—View from outside of right antenna. Scale: 0.1 mm. S—Sensory organ.
FIG. 9.—First thoracic leg of right side. Scale: 0.1 mm. R—Setae representing the respiratory plate.

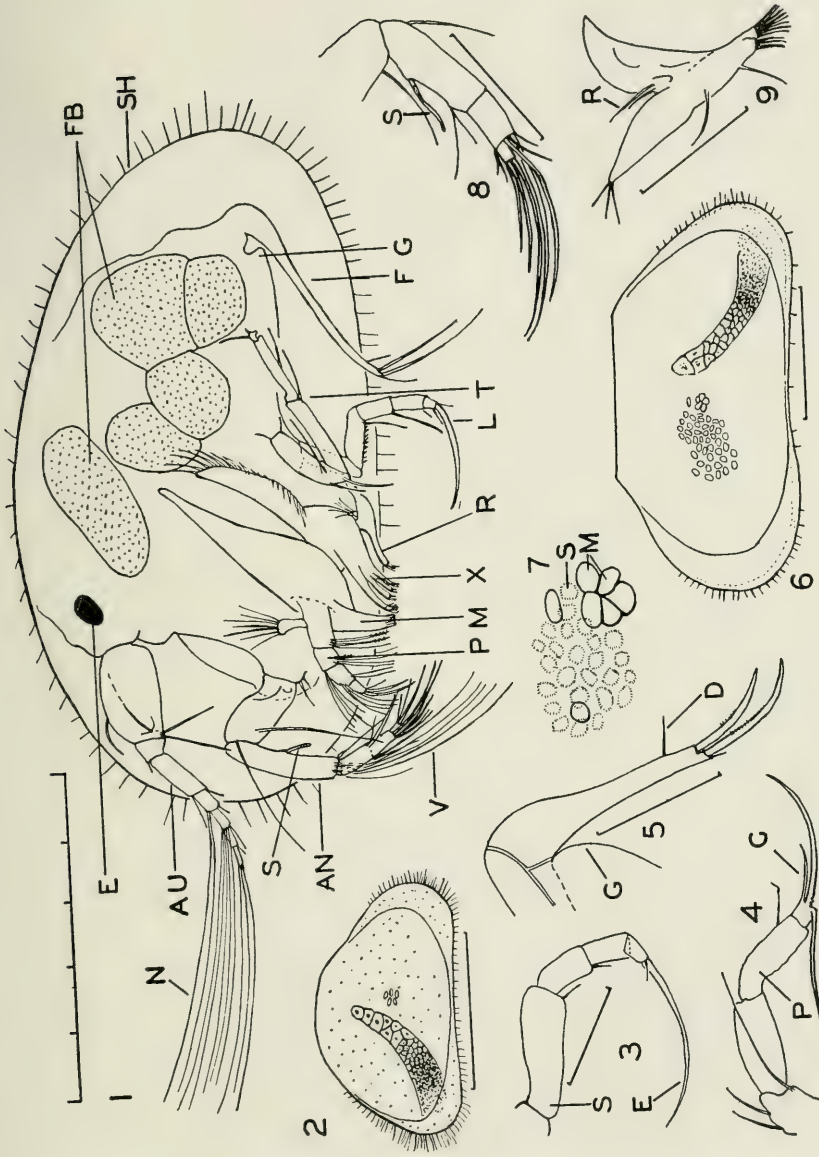


PLATE I

PLATE II

Candona fluviatilis sp. nov.; female.

FIG. 10.—Third thoracic leg. Scale: 0.05 mm. P—Penultimate podomere showing undivided condition. S—Second podomere.

FIG. 11.—Furca and female genital lobe. Scale: 0.1 mm.

G—Genital lobe
P—Dorsal seta
S—Subterminal claw
T—Terminal claw
V—Terminal seta

Candona simpsoni Sharpe 1897; female.

FIG. 12.—Outline drawings of the shells of several specimens. Scale: 0.5 mm.

FIG. 13.—Third thoracic leg showing a combination of characters of the "simpsoni" form (as the spines on the margins of the antepenultimate and penultimate podomeres) and the "exilis" form (as the curved tip of the shortest distal claw). Scale: 0.1 mm.

FIG. 14.—Furca showing an S-shaped subterminal claw. Scale: 0.1 mm. S—Subterminal claw.

FIG. 15.—Furca showing a nearly straight subterminal claw, the dorsal thoracic seta, and the genital lobe. Scale as in fig. 14. D—Dorsal thoracic seta. G—Genital lobe.

FIG. 16.—Furca showing straight and slender claws. Scale as in fig. 14.

FIG. 17.—Furca of an immature individual just before the molt in which the third thoracic leg appears. The terminal seta of the furca is not developed. Scale: 0.05 mm. T—Terminal claw.

Candona albicans Brady 1864.

FIG. 18.—View from outside of the right valve of female. Scale as in fig. 21. O—Ovary.

FIG. 19.—End of the third thoracic leg of a female. Scale: 0.1 mm. P—Divided penultimate podomere.

FIG. 20.—Furca of female. Scale: 0.1 mm.

FIG. 21.—Inside view of the right valve of male. Scale: 0.5 mm. T—Testis.

FIG. 22.—Prehensile palps of male; (a) outside view of left palp; (b) inside view of right palp. Scale: 0.025 mm.

FIG. 23.—Penis. Scale: 0.1 mm.

Candona biangulata sp. nov.; female.

FIG. 24.—Inside view of the right valve (holotype). Scale: 0.25 mm.

FIG. 25.—Mandibular palp. Scale: 0.05 mm. B—Group of seta of antepenultimate podomere. F—Basal podomere of palp or the second podomere of the protopodite.

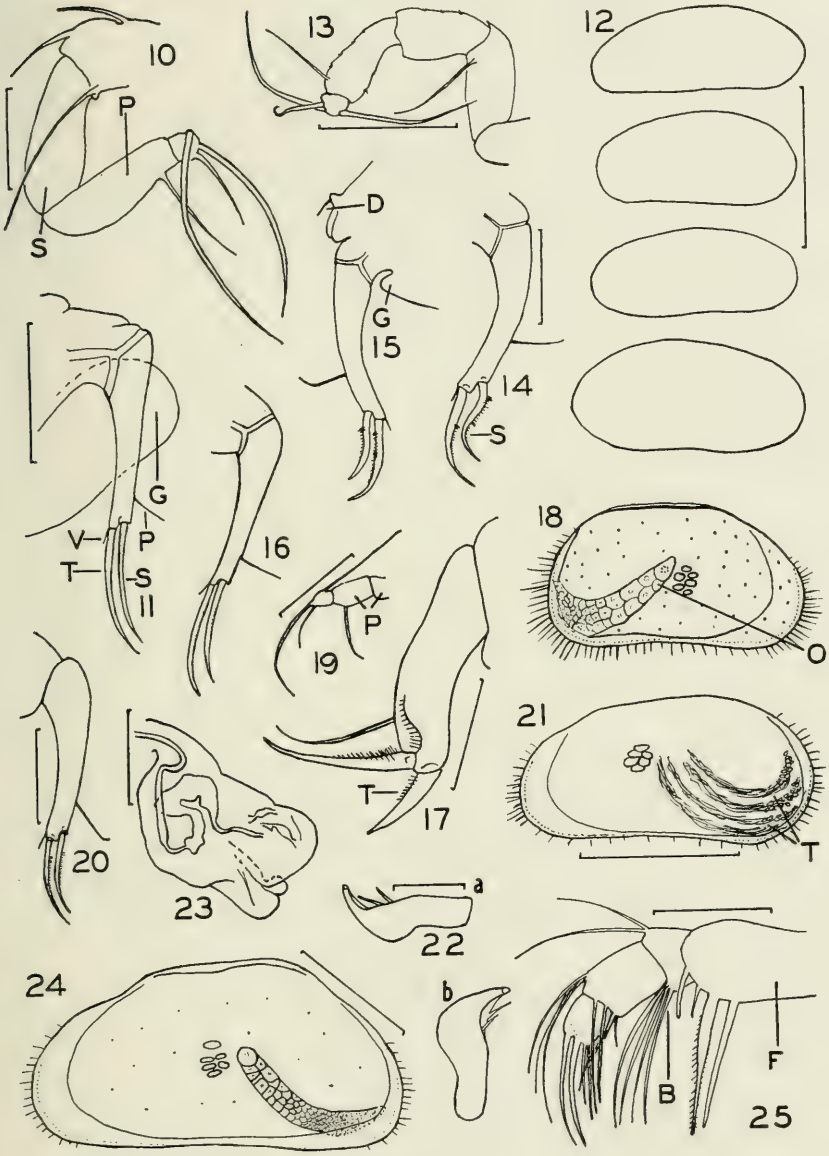

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PLATE II

PLATE III

Candona biangulata sp. nov.; female.

FIG. 26.—Second thoracic leg (mounted in glycerine). Scale: 0.1 mm. A—Second podomere. C—Distal claw. P—Penultimate podomere. U—Ultimate or fifth podomere.

FIG. 27.—Third thoracic leg (holotype). Scale: 0.5 mm.

FIG. 28.—Furca and genital lobe (holotype). Scale: 0.1 mm. G—Genital lobe.

Candona distincta Furtos 1933; female.

FIG. 29.—Outside view of left valve. Scale: 0.5 mm.

FIG. 30.—Furca and genital lobe. Scale: 0.1 mm. G—Genital lobe.

Candona crogmaniana Turner 1894; female.

FIG. 31.—Inside view of right valve. Scale as in fig. 33.

FIG. 32.—Base of furcal ramus and genital lobe. Scale: 0.1 mm. G—Genital lobe.

Candona caudata Kaufmann 1900; female.

FIG. 33.—Inside view of left valve. Scale: 0.25 mm.

FIG. 34.—Distal portion of the third thoracic leg showing divided penultimate podomere. Scale: 0.1 mm. P—Setae of similarly directed pair.

FIG. 35.—Furca and genital lobe. Scale: 0.2 mm.

Candona sigmoides Sharpe 1897.

FIG. 36.—Outside view of left valve of female. Scale: 0.5 mm.

FIG. 37.—Furca and genital lobe of female. Scale: 0.2 mm.

B—Base or ramus of furca	G—Genital lobe
C—Subterminal claw	S—Terminal seta
D—Dorsal seta	T—Terminal claw

FIG. 38.—Penis (mounted in glycerine). Scale: 0.2 mm.

Candona indigena sp. nov.

FIG. 39.—Lateral view of female from the left side (holotype; in alcohol). Scale as in fig. 36. S—Swimming setae of antennules.

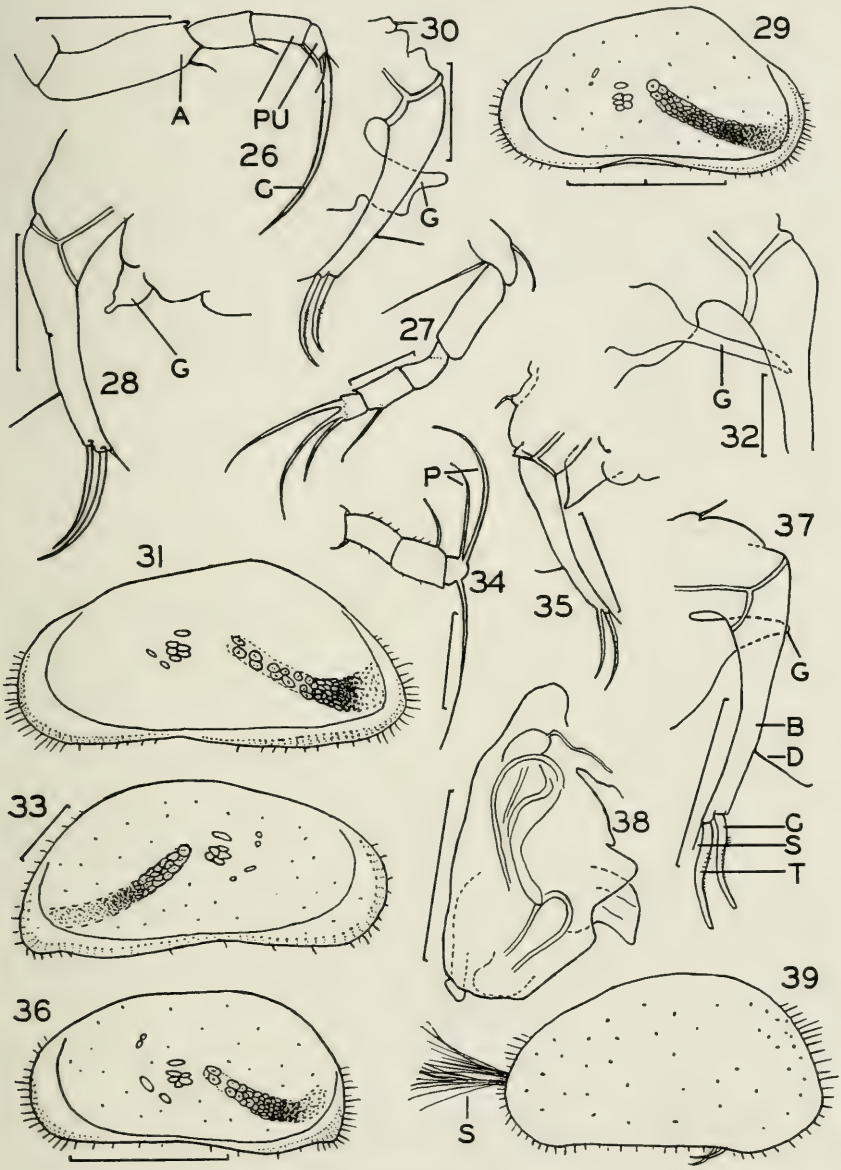

PLATE III

PLATE IV

Candona indigena sp. nov.

FIG. 40.—View from outside of right valve of female (paratype). Scale as in fig. 41.

A—Anterior margin of shell
C—Pore-canals
D—Dorsal margin of shell
M—Muscle scars
O—Ovary
P—Posterior margin of shell
S—Ventral sinuation
V—Ventral margin

FIG. 41.—View from outside of left valve of male (paratype). Scale: 0.5 mm. T—Testis.

FIG. 42.—Dorsal view of female (holotype in alcohol). Scale as in fig. 41. S—Swimming setae of antennules.

FIG. 43.—Mandible (holotype). Scale: 0.1 mm. C—Chewing edge. P—Penultimate podomere. R—Branchial or respiratory plate. S—Setae bundle.

FIG. 44.—Distal podomeres of the second thoracic leg of male (allotype). Scale: 0.1 mm.

FIG. 45.—Third thoracic leg of female (holotype). Scale: 0.1 mm.

FIG. 46.—Furca and female genital lobe (paratype) with furcal ramus extended posteriorly. Scale as in fig. 45. G—Genital lobe.

FIG. 47.—Prehensile palps (allotype); (a) right palp seen from the inside; (b) left palp viewed from the outside. Scale as in fig. 45.

FIG. 48.—Penis (allotype). Scale: 0.1 mm. V—Vas deferens. O—Bifurcated outer lobe.

Candona suburbana sp. nov.

FIG. 49.—Inside view of right valve of female (allotype). Scale: 0.5 mm.

FIG. 50.—Inside view of right valve of male (paratype). Scale as in fig. 49.

FIG. 51.—Dorsal view of male (holotype; in alcohol). Arrow indicates the anterior end. Scale as in fig. 49.

FIG. 52.—Second thoracic leg of female (allotype). Scale: 0.1 mm.

FIG. 53.—Third thoracic leg of male (holotype). Scale as in fig. 52. S—Setae of the similarly directed pair. P—Divided penultimate podomere.

FIG. 54.—Proximal portion of the furcal ramus and the genital lobe of the female (allotype). Scale as in fig. 52. G—Genital lobe.

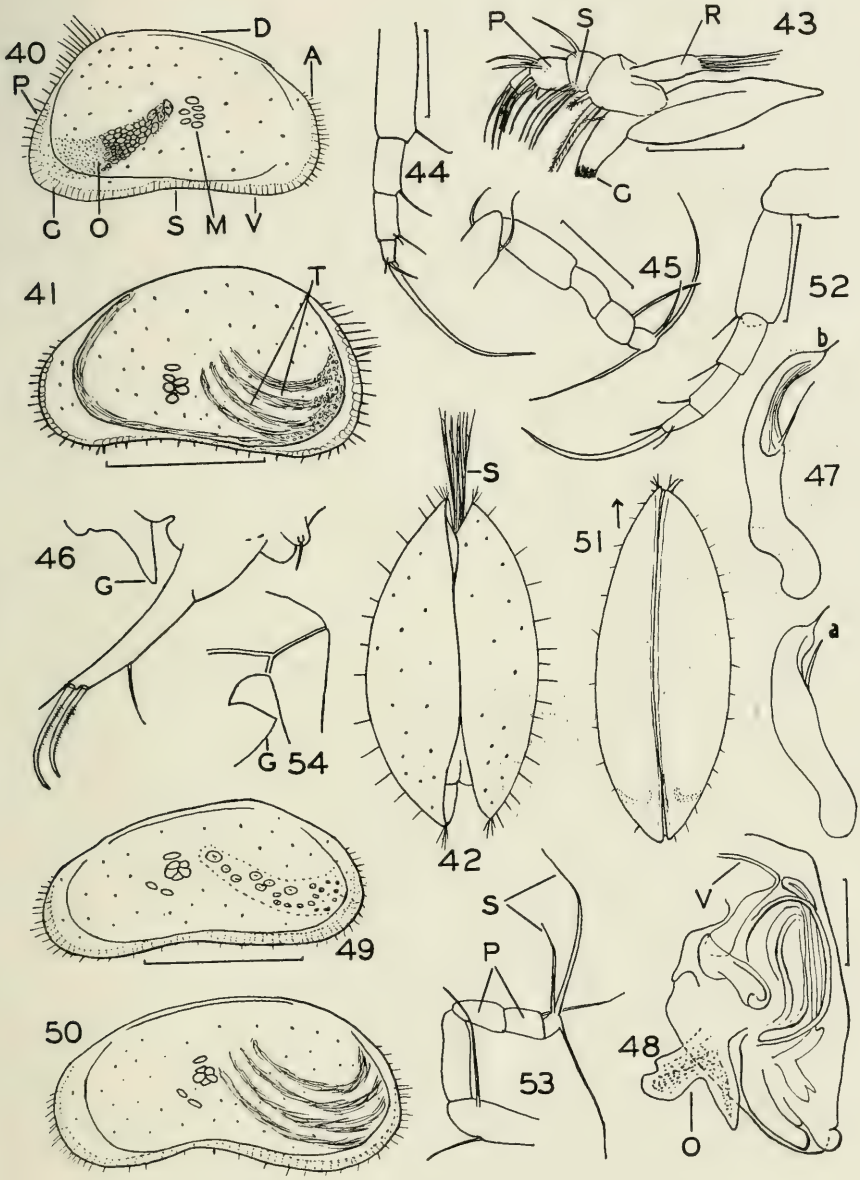
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PLATE IV

PLATE V

Candona suburbana sp. nov.

FIG. 55.—Furca of male (paratype). Scale: 0.1 mm.

FIG. 56.—Prehensile palps of male (paratype); (a) inside view of the left palp; (b) inside view of the right palp. Scale as in fig. 57.

FIG. 57.—Penis (paratype). Scale: 0.1 mm. I—Inner lobe of penis. M—Middle lobe of penis. O—Outer lobe of penis. V—Vas deferens.

Candona fossulensis sp. nov.

FIG. 58.—Inside view of left valve of female (holotype). Scale: 0.5 mm.

FIG. 59.—Markings on posterior slope of shell of female (paratype). Scale as in fig. 55.

FIG. 60.—Mandibular palp of female (paratype). Scale: 0.1 mm. S—Bundle of setae of antepenultimate podomere.

FIG. 61.—Third leg of female (paratype). Scale as in fig. 57.

FIG. 62.—Furca and genital lobe of female (paratype). Scale as in fig. 55.

FIG. 63.—Prehensile palps of male (allotype); (a) outside view of right; (b) outside view of left. Scale as in fig. 57.

FIG. 64.—Penis of male (paratype). Scale: 0.2 mm.

Candona acuta sp. nov.

FIG. 65.—Inside view of right valve of female (holotype). Scale: 0.5 mm.

FIG. 66.—View from ventrad of the left valve of female (holotype in alcohol). Arrow indicates anterior end. Scale as in fig. 65.

FIG. 67.—Second leg of female (paratype). Scale: 0.1 mm. F—First podomere. P—Penultimate podomere. S—Second podomere.

FIG. 68.—Third leg of female (paratype). Scale: 0.1 mm. P—Parts of the divided penultimate podomere.

FIG. 69.—Furca of the female (holotype). Scale: 0.1 mm.

B—Seta of dorsal-posterior part of the thorax
D—Dorsal seta of furca
G—Genital lobe
R—Ramus of furca
S—Terminal seta
T—Terminal claw
U—Subterminal claw

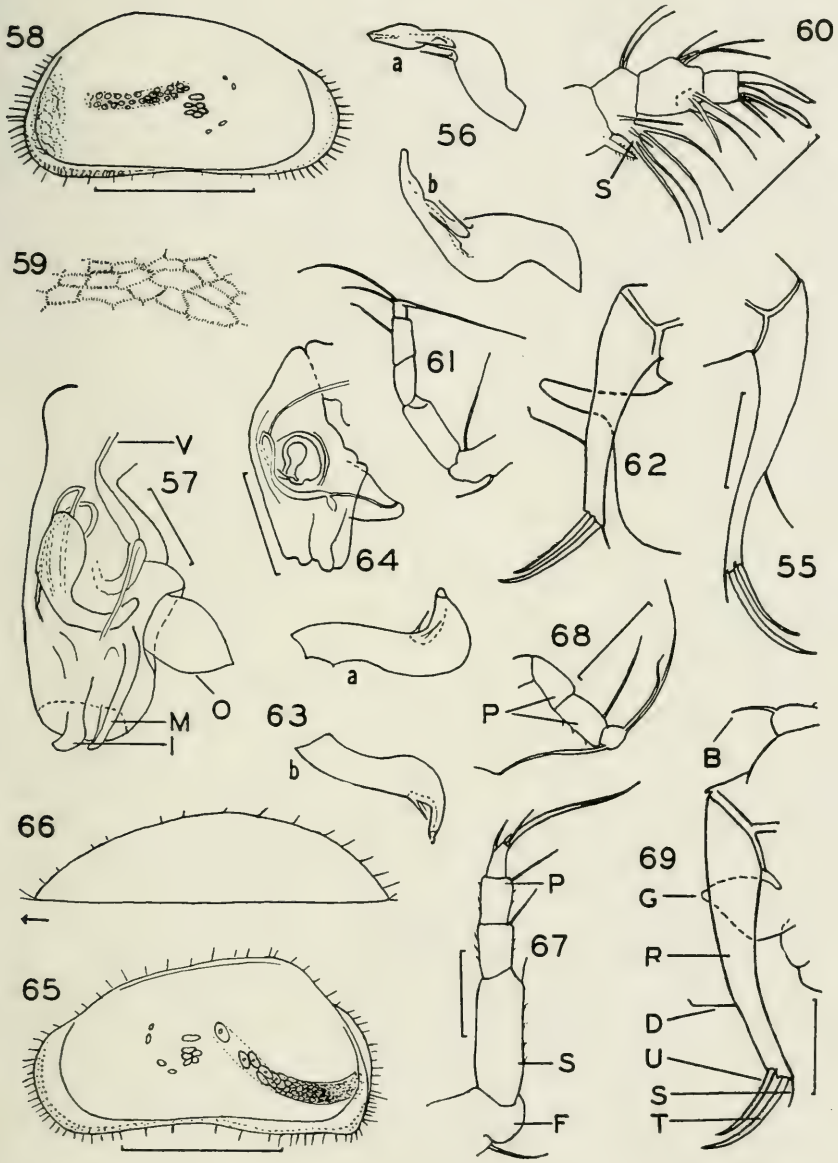

PLATE V

PLATE VI

Candona acuta sp. nov.

FIG. 70.—Inside view of left valve of male (allotype). Scale: 0.5 mm.
FIG. 71.—Prehensile palps of the male (paratype); (a) inside view of left palp; (b) inside view of right palp. Scale: 0.1 mm.
FIG. 72.—Penis (allotype). Scale: 0.2 mm. I—Inner lobe. M—Middle lobe. O—Outer lobe.

Cyclocypris forbesi Sharpe 1897; female.

FIG. 73.—Inside view of left valve of shell. Scale: 0.25 mm.
FIG. 74.—Second thoracic leg. Scale: 0.1 mm.
FIG. 75.—Third thoracic leg. Scale as in fig. 74.

Cypria turneri sp. nov.

FIG. 76.—View of the left side of the female (paratype in alcohol). Scale: 0.25 mm. A—Swimming setae of antennae. E—Eye. M—Muscle scars. S—Swimming setae of antennules.
FIG. 77.—Ventral view of the left valve of female (in alcohol). The arrow points toward the anterior end.
FIG. 78.—Characteristic markings on the shell. Scale: 0.025 mm.
FIG. 79.—Furca of male (paratype). Scale: 0.1 mm.
FIG. 80.—Prehensile palps of the male (allotype); (a) left palp seen from inside; (b) right palp viewed from outside. Scale as in fig. 79. D—Dactylus. P—Propodus.
FIG. 81.—Penis of male (paratype). Scale as in fig. 79. I—Inner lobe. M—Middle lobe.

Cypria mediana sp. nov.

FIG. 82.—Outside view of right valve of female (paratype). Scale: 0.5 mm.
FIG. 83.—Ventral view of left valve of female (holotype in alcohol). Arrow indicates the anterior end. Scale as in fig. 82.
FIG. 84.—Third thoracic leg of female (holotype). Scale: 0.1 mm.
FIG. 85.—Furca of female (paratype). Scale as in fig. 84.
FIG. 86.—Inside view of right valve of male (allotype). Scale as in fig. 82.
FIG. 87.—Penis (allotype). Scale as in fig. 84.

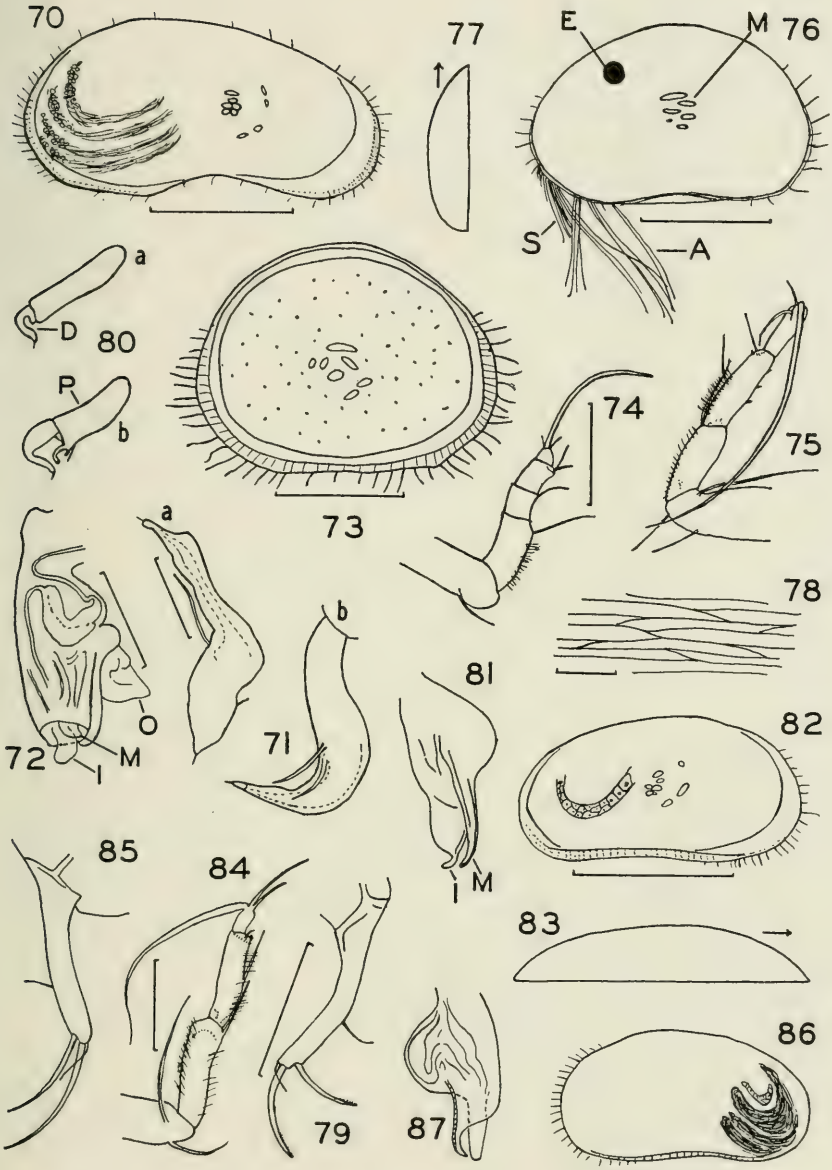
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PLATE VI

PLATE VII

Cypria obesa Sharpe 1897; female.

FIG. 88.—Inside view of right valve. Scale: 0.5 mm.
FIG. 89.—Distal portion of the third thoracic leg. Scale: 0.1 mm.

Cypria maculata sp. nov.

FIG. 90.—Inside view of left valve of female (holotype). Scale: 0.25 mm.
FIG. 91.—Third thoracic leg of female (paratype). Scale as in fig. 89.
FIG. 92.—Furca of female (holotype). Scale as in fig. 89.
FIG. 93.—Ductus ejaculatorius of the male. Scale as in fig. 89.
FIG. 94.—Prehensile palps of male: (a) outside view of left palp; (b) inside view of right palp. Scale: 0.05 mm.
FIG. 95.—Penis. Scale as in fig. 94. I—Inner lobe. M—Middle lobe.

Cypria ophthalmica (Jurine 1820) Brady and Norman 1889; female.

FIG. 96.—Animal viewed from left side. Scale: 0.25 mm.
FIG. 97.—Pattern of color markings on the shell. Scale: 0.05 mm.

Physocypria pustulosa Sharpe 1897; female.

FIG. 98.—Right valve viewed from the inside. Scale as in fig. 96.

Ilyocypris gibba (Ramdohr 1808) Brady and Norman 1889; female.

FIG. 99.—Right valve seen from the outside. (Sculpturing shown only on the posterior part of the shell.) Scale: 0.5 mm. F—Furrows. M—Flattened margin. P—Protuberances.
FIG. 100.—Second thoracic leg. Scale: 0.1 mm.

Ilyocypris bradyi Sars 1890; female.

FIG. 101.—Left valve seen from outside. (Shell sculpturing shown only on posterior part of shell.) Scale as in fig. 99.
FIG. 102.—Distal portion of the second thoracic leg (mounted in glycerine). Scale as in fig. 100. P—Two divisions of the penultimate podomere.

Cypricercus tuberculatus (Sharpe 1908) *comb. nov.*

FIG. 103.—Outside view of right valve of female. Arrow indicates anterior end. Scale: 0.5 mm.
FIG. 104.—Penis. Scale: 0.1 mm.

Cypricercus reticulatus (Zaddach 1844) Sars 1928.

FIG. 105.—Outside view of the right valve of female. Scale: 0.5 mm.

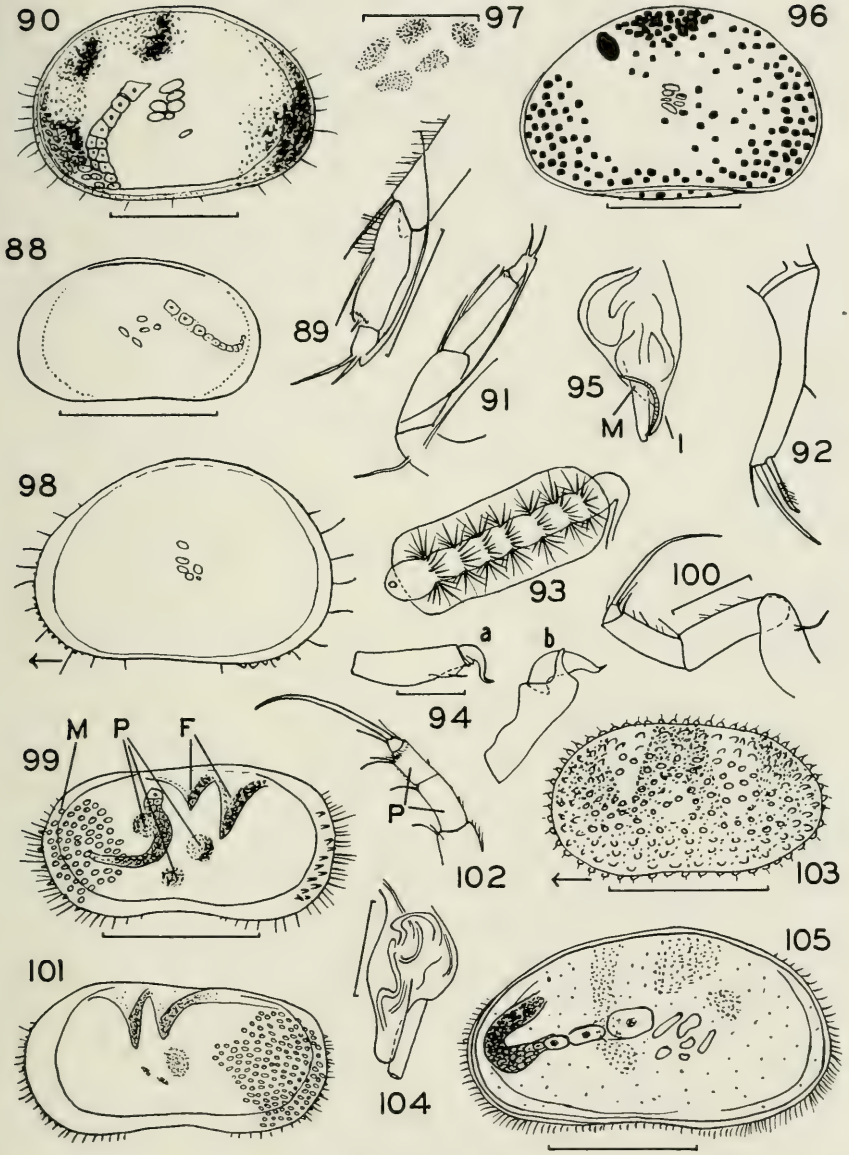
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PLATE VII

PLATE VIII

Cypricercus reticulatus (Zaddach 1844) Sars 1928.

FIG. 106.—Portion of the antenna of the female. Scale: 0.1 mm. A—Antepenultimate podomere. B—Seta with bulbous base. O—Sensory organ. S—Swimming setae.

FIG. 107.—Furca of female. Scale: 1.5 mm.

FIG. 108.—Outline drawing of the shell of the male. Arrow indicates the anterior end. A—Anterior portion of testis. P—Posterior portion of testis.

FIG. 109.—Penis. Scale as in fig. 106. L—Middle lobe. V—Vas deferens.

Cyprinotus incongruens (Ramdohr 1808) Turner 1895; female.

FIG. 110.—Inside view of right valve. Scale: 1.0 mm.

FIG. 111.—Furca. Scale: 0.5 mm.

Notodromas monacha (O. F. Müller 1776) Lilljeborg 1853; male.

FIG. 112.—Outside view of the left valve. Arrow indicates the anterior end. Scale: 0.5 mm.

FIG. 113.—Outer masticatory process of the maxilla. Scale: 0.05 mm.

FIG. 114.—Furca. Scale: 0.25 mm.

Cypridopsis vidua (O. F. Müller 1776) Brady 1867; female.

FIG. 115.—View of left side. Arrow indicates the anterior end. Scale: 0.5 mm.

FIG. 116.—Anterior margin of the right valve to show the tubercles. Scale: 0.1 mm.

FIG. 117.—Furca. Scale: 0.1 mm. F—"Flagellum."

Potamocypria smaragdina (Vávra 1891) Daday 1900.

FIG. 118.—Female viewed from the right side. Scale: 0.25 mm. C—Claws of second thoracic legs. S—Swimming setae of antennae.

FIG. 119.—End of maxillary palp to show distally widened ultimate podomere. Scale: 0.025 mm.

FIG. 120.—Outside view of terminal end of the right third thoracic leg to show the chela or "pincers apparatus."

FIG. 121.—Outside view of left valve of the male. Arrow points to the anterior end. Scale: 0.25 mm. A—Anterior portion of the testis. F—Anterior flange of shell.

FIG. 122.—Prehensile palps of the male; (a) outside view of the left palp; (b) inside view of the right palp. Scale: 0.05 mm. D—Dactylus. P—Propodus.

FIG. 123.—Ductus ejaculatorius of male. Scale as in fig. 122. V—Vas deferens.

FIG. 124.—Penis. Scale: 0.1 mm.

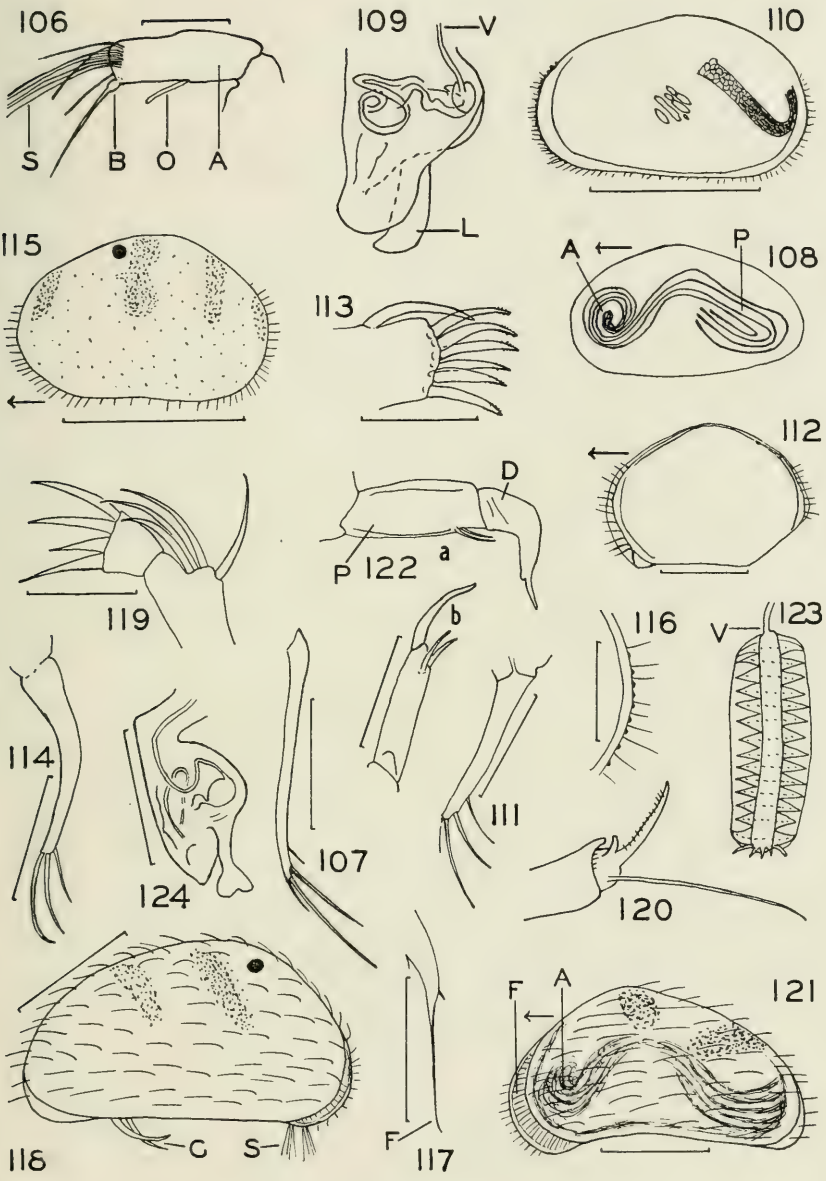
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PLATE VIII

PLATE IX

Darwinula stevensoni (Brady and Robertson 1870) Brady and Norman 1889; female.

FIG. 125.—Inside of left valve. Scale: 0.25 mm.

FIG. 126.—End of thorax. Arrow points ventrally. Scale: 0.05 mm.

Limnocythere verrucosa sp. nov.

FIG. 127.—Outside view of right valve of female. (Sculpturing omitted.) Scale as in fig. 125. F—Furrows. M—Anterior margin with pore-canals. P—Protuberances. S—Muscle scars.

FIG. 128.—A portion of the anterior margin of the shell. Scale: 0.1 mm. H—Setae. P—Pore-canals. S—Sculpturing. T—Tubercles.

FIG. 129.—Shell of female from above. Arrow indicates the anterior end. Scale as in fig. 125.

FIG. 130.—End of the antennule of the female to show the terminal and subterminal setae. Scale as in fig. 126. F—Fused portion of terminal setae.

FIG. 131.—View from the outside of the left antenna of the female. Scale: 0.1 mm. A—Articulation of parts of "flagellum." F—Basal portion of "flagellum" or exopodite. T—Antepenultimate podomere or first podomere of the endopodite.

FIG. 132.—Furca of female. Scale: 0.025 mm. P—Papilla with dorsal seta.

FIG. 133.—Outside view of right valve of male. (Surface markings not shown.) Scale as in fig. 125.

FIG. 134.—Outside view of right penis. Scale: 0.1 mm. F—Furca.

FIG. 135.—"Brush-form" sensory organ of male. Scale: 0.05 mm. B—Pedicel to to which organ is attached. S—Distal setae.

Limnocythere reticulata Sharpe 1897.

FIG. 136.—Inside view of the left valve of the female. Scale: 0.5 mm.

FIG. 137.—Anterior and posterior ends of inside of the dorsal margin of the right valve of female to show the teeth. (Center of dorsal margin omitted.) AT—Anterior teeth. PT—Posterior teeth.

FIG. 138.—Furca of female. Scale: 0.05 mm. D—Dorsal seta.

FIG. 139.—Third thoracic leg of the male. Scale: 0.1 mm.

FIG. 140.—Shell of male viewed from the right side. Scale as in fig. 136.

FIG. 141.—Penis in outside view from the left. Scale: 0.25 mm.

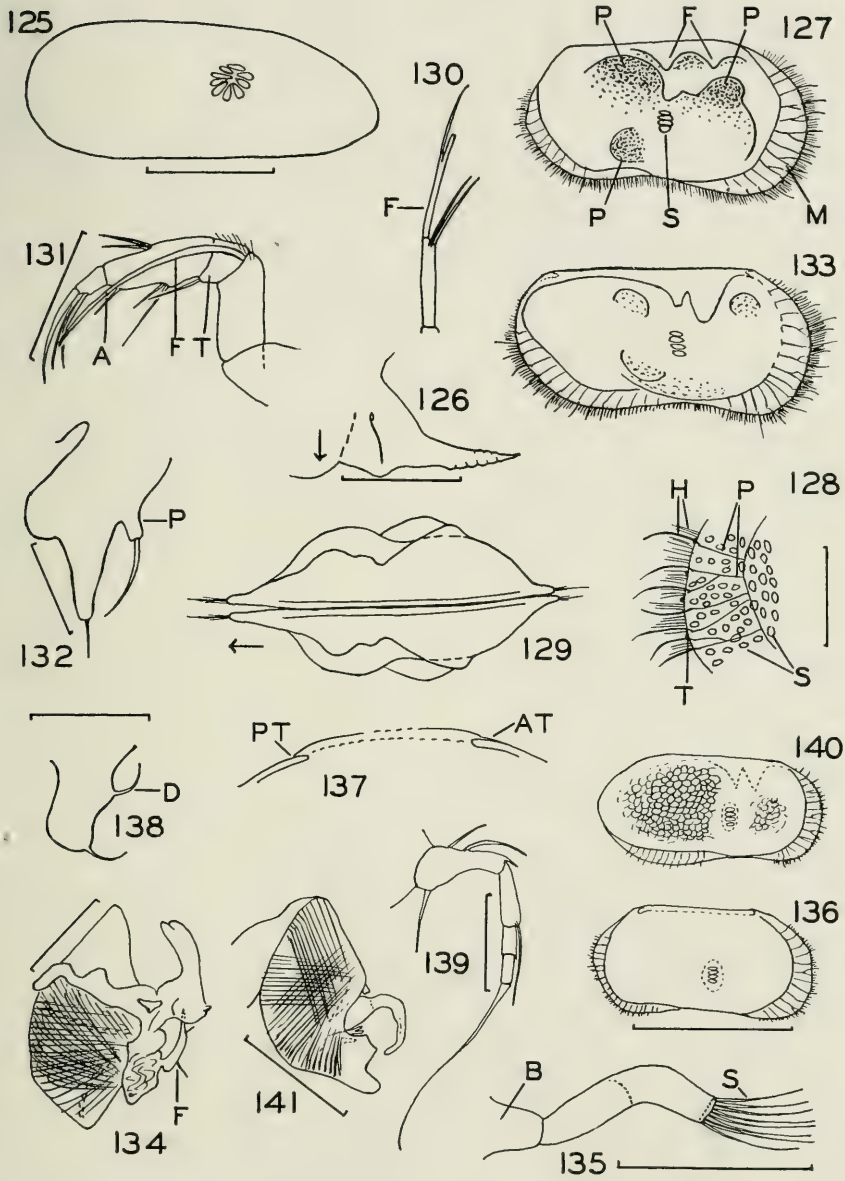
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PLATE IX

INDEX

The names of new species are printed in **bold-face** type. The names of other species known from Illinois and the page numbers referring to specific diagnoses are given in *italics*.