



COMMENTS ON SOME QUATERNARY OSTRACODE TAXA FROM NORTHWEST INDIA

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ABSTRACT

This paper elucidates aspects like ontogeny and ecology/palaeoecology of thirty eight fresh-water ostracode taxa collected from the Plio-Pleistocene (Karewas) and Recent of the Kashmir valley. Besides contributing towards our existing information regarding behaviour of these interesting micro-organisms, this paper also incorporates brief comments on several of the aspects, *viz.*, general morphological characteristics, dimorphism, taxonomy, palaeozoogeography, provenance and distribution etc.

INTRODUCTION

A rich and varied fresh-water ostracode fauna has been recorded and studied from the Plio-Pleistocene deposits (known as 'Karewas') and the Recent of the Kashmir valley, in the past seven years. As accepted by most of the workers, the Karewas, chiefly comprising silts and clays, are of Plio-Pleistocene age and of fresh-water origin, partly lacustrine and partly fluvial in nature. Of these, the Lower Karewas which are unconformably separated from the Upper Karewas, are generally agreed to be of Plio-Pleistocene age, deposited chiefly under fluvial conditions; however, their lower age limit is considered to be a controversial matter by Roy (1971) and Singh (1973a). The Upper Karewas are accepted to be of Pleistocene age, deposited chiefly under a lacustrine environment.

For the present study, the fossil collections were made from a number of representative sections of the Lower as well as Upper Karewas, from all over the valley; while the recent collections were made from several lakes, ponds, rice fields and spring waters of the valley. The study of the living ostracode species was made in view of usefulness of ecology in deciphering Plio-Pleistocene palaeoecology.

As a matter of fact, the study of fresh-water ostracodes of the Indian subcontinent is still in its infancy. Particularly, regarding the Quaternary ostracode fauna of the Kashmir valley, a very little amount of work has, so far, been done. The few contributions in this regard are by Bhatia (1968 *et seq.*), Singh (1969 *et seq.*) and Bhatia and Singh (1970a-c, 71b).

The present paper deals mainly with ontogeny and ecology/palaeoecology of the individual ostracode species. The detailed information regarding their distribution in the Kashmir valley can be had from the two of the author's earlier works, *viz.*, Singh (1973d and 74b). Since all the species discussed herein are already well known, their synonymies have been omitted for the sake of brevity. However, brief comments where necessary have been incorporated under the sub-heading 'Remarks'. For the purpose of classification, the one given by Moore (1961) in the treatise on ostracoda, has been followed with slight modification.

CHECK-LIST

Cypris pubera Mueller
Cypris subglobosa Sowerby
Dolerocypris sp. cf. *D. fasciata* (Mueller)
Eucypris sp. cf. *E. clavata* (Baird)
Eucypris sp. cf. *E. moguntiensis* Triebel
Eucypris zenkeri (Chyzer and Toth)
Herpetocypris reptans (Baird)
Heterocypris incongruens (Ramdohr)
Isocypris priomena Mueller
Stenocypris major (Baird)
Zonocypris costata (Vavra)
Cypridopsis aculeata (Lilljeborg)
Cypridopsis vidua (Mueller)
Potamocypris minuta patriciae Bhatia
Potamocypris smaragdina (Vavra)
Potamocypris (Cyprilla) arcuata (Sars)
Potamocypris (Cyprilla) humilis (Sars)

Candona candida (Mueller)
Candona compressa (Koch)
Candona fabaeformis (Fischer)
Candona sp. cf. *C. havanaensis* Staplin
Candona lactea Baird
Candona marengoensis Klie
Candona neglecta Sars
Candona sp. cf. *C. pearlensis* Staplin
Candona rawsoni Tressler
Candona sp. cf. *C. stammeri* Klie
Candonopsis Kingsleii (Brady and Robertson)
Cyclocypris laevis (Mueller)
Cyclocypris ovum (Jurine)
Cypria ophthalmica (Jurine)
Ilyocypris bradyi Sars
Ilyocypris gibba (Ramdohr)
Ilyocypris shawneetownensis Staplin
Darwinula stevensoni (Brady and Robertson)
Cytherissa lacustris (Sars)
Limnocythere blankenbergensis Diebel
Limnocythere franki Bhatia

SYSTEMATIC DESCRIPTION

Subclass Ostracoda Latreille, 1806
Order Podocopida Mueller, 1894
Suborder Podocopina Sars, 1866
Superfamily Cypridacea Baird, 1845
Family Cyprididae Baird, 1845
Subfamily Cypridinae Baird, 1845
Genus *Cypris* Mueller, 1776

Cypris pubera Mueller, 1776

(Pl. I—1-11)

Remarks: This is a well-known holarctic species. The species is the genotype, originally described from the Recent of Europe by Mueller (1776). In the Kashmir valley it ranges from the Pleistocene (Up. Karewas) to the Recent.

Ontogeny: Seven instars are present in the material at hand; the earliest being probably the II. Instars II to IV are more triangular in outline, while others, in general, are more akin to the adult. The pits on the shell surface of the juveniles are elongate, curved, zoned in a concentric manner. The anterior and posterior spines start developing in the IV instar. In the V instar, six anterior and two posterior spines are noticeable. The number of spines gradually increases in the subsequent instars.

Ecology/Palaeoecology: The species is characteristic of ponds of different kinds and sizes (Klie, 1938b; Dobbin, 1941; and Diebel and Pietrzeniuk, 1969). It is commonly found in swarms especially in slightly brackish-water pools and swamps (Stephanides, 1948).

Besides, the species also inhabits the rice fields (Fox, 1965a).

In the Kashmir valley, the species occurs frequently in the foul, stagnant pond waters with rich vegetation matter, in association with large numbers of *Eucypris* sp. cf. *E. clavata* (Baird), *Heterocypris incongruens* (Ramdohr), *Potamocypris smaragdina* (Vavra) and *Potamocypris (Cyprilla) staplini* Singh (Singh, 1973d).

The Pleistocene specimens occur in large numbers in the lake deposits of the Karewas, with rich vegetation matter, in association with shallow water species, mainly *Candona marengoensis* Klie, *Eucypris* sp. cf. *E. clavata* (Baird), *Heterocypris incongruens* (Ramdohr), *Cypridopsis aculeata* (Lilljeborg) and *Ilyocypris bradyi* Sars.

Cypris subglobosa Sowerby, 1840

(Pl. II—1-8)

Remarks: This species is known from the Holarctic as well as the Oriental provinces. It has been originally described from India by Sowerby (1840) in Malcolmson. However, its provenance has been discussed to a good length by Bhatia (1968b). In the Kashmir valley, the species is confined to the Pleistocene (Up. Karewas).

Ontogeny: Only five instars II to V and VII could be recognised in the material. Instars II to V are more triangular in lateral outline while the instar VII is more akin to the adult. Four to five posterior spines appear in the V instar, increasing to thirteen in the VII.

Ecology/Palaeoecology: This species occurs abundantly in the fresh-water ponds, pools and also sometimes in lakes (Baird, 1859; Klie, 1933a and Tressler, 1959 in Edmondson). Petkovski (1964) also records it from the rice fields.

The Pleistocene specimens occur abundantly in the fresh-water lake silts of the Karewas in association with species of shallow depths, mainly *Candona lactea* Baird and *Candona neglecta* Sars.

Genus Dolerocypris Kaufmann, 1900

Dolerocypris sp. cf. *D. fasciata* (Mueller, 1785)

(Pl. II—9-12)

Remarks: The species appears to be close to *Dolerocypris fasciata* (Mueller, 1785). In the Kashmir valley, it is of a very restricted occurrence, being found only in the Pleistocene (Up. Karewas).

Ontogeny: Only two late intermediate instars could be collected, which in general outline are similar to the adult.

Ecology/Palaeoecology: This species is a good swimmer, having a preference for ponds and small lakes with abundant vegetation. In large lakes, it inhabits only the marginal shallow parts. It also occurs in swamps, temporary water bodies and in reeds (Klie, 1933a, 1938b;

Jarvekulg, 1959 ; Akatova and Jarvekulg, 1965 and Fox, 1965b, 66b). It may also occur in polyhaline waters (McKenzie, 1964).

The Pleistocene specimens occur in lacustrine silt deposits of the valley, with moderate vegetation matter, associated with a shallow-water assemblage comprising *Candona marengoensis* Klie, *Candonopsis kingsleii* (Brady and Robertson), *Ilyocypris bradyi* Sars, *I. shawneetownensis* Staplin and *Limnocythere franki* Bhatia.

Genus *Eucypris* Vavra, 1891

Eucypris sp. cf. *E. clavata* (Baird, 1938)
(Pl. III—1-3 ; Pl. IV—1-5)

Remarks : This is a typical Palaearctic species, ranging from the Pleistocene (Up. Karewas) to the Recent in the Kashmir valley. The specimens are close to *Eucypris clavata* (Baird) originally described from the Recent of Britain, except for the slight differences in outlines (*vide* Dr. K. G. McKenzie, personal communication).

Ontogeny : Seven instars, *viz.*, II to VIII were noted in the present material. In general outline all are akin to the adults. However, the posterior marginal spines which appear to be worn out in the adults, are present in all the instars. The number of these posterior spines is two in the II instar, gradually increasing to as many as fourteen to sixteen in the VII and VIII. The salvage approaches the outer margin in the early intermediate instars.

Ecology/Palaeoecology : The species is commonly found in temporary pools and pits with luxurious vegetation, muddy bottoms and foul waters. Though it can undoubtedly swim, it prefers burrowing in the muddy bottoms (Baird, 1838 ; Brady, 1868 ; Brady and Norman, 1889 ; Gurney, 1920 ; and Klie, 1938b).

In the Kashmir valley, it is found living in large numbers in stagnant pond waters with rich vegetation, mainly in association with *Cypris pubera* Mueller, *Heterocypris incongruens* (Ramdohr) and *Potamocypris smaragdina* (Vavra) (*vide* Singh, 1973d). In the Pleistocene fresh-water lacustrine silt deposits with rich vegetation matter, it occurs in association with a varied assemblage of shallow-water species, comprising mainly *Candona marengoensis* Klie, *Cypris pubera* Mueller, *Heterocypris incongruens* (Ramdohr), *Cypridopsis aculeata* (Lilljeborg) and *Ilyocypris bradyi* Sars.

Eucypris sp. cf. *E. moguntiensis* Triebel, 1963
(Pl. IV—6)

Remarks : The species is close to *Eucypris moguntiensis* Triebel (1963), originally described from the Lower Miocene of the Mine Basin, Germany. In the Kashmir valley, this species occurs in the Plio-Pleistocene being common to both the Lower and the Upper Karewas.

Palaeoecology : Only fossil specimens were found in the Kashmir valley in shallow lacustrine silt deposits in association with a rich assemblage of candonids.

Eucypris zenkeri (Chyzer and Toth, 1858)
(Pl. IV—7-14)

Remarks : This is a well-known Palaearctic species. It occurs only in the Pleistocene (Up. Karewas) of the Kashmir valley.

Ontogeny : Only five instars, IV to VIII were recognised. Their general outline is similar to that of the adult, though in the IV to VII instars, the dorsal margin is slightly sinuate. The marginal spines first appear in V instar and progressively increase in number in the later ones.

Ecology/Palaeoecology : This species is characteristic of sluggishly flowing water rich in vegetation. However, it also occurs in the lake waters (Brady, 1868, and Klie, 1938b).

In the Kashmir valley, the Pleistocene specimens occur in the shallow fresh-water, lacustrine silt deposits rich in vegetation matter, in association with *Candona lactea* Baird, *C. neglecta* Sars, *Cypris ophthalmica* (Jurine), *Cypridopsis nidua* (Mueller) and *Ilyocypris bradyi* Sars.

Genus *Herpetocypris* Brady and Norman, 1889

Herpetocypris reptans (Baird, 1835)
(Pl. V—1-4 ; Pl. VI—1-4)

Remarks : This well-known species, the genotype of *Herpetocypris* Brady and Norman, was originally described from the Recent, Great Britain, by Baird (1835). The species occurs in both the Holarctic as well as the Ethiopian provinces. In the Kashmir valley, the species occurs only in the Pleistocene (Up. Karewas). The adductor muscle scars in this species, though well defined, are brushy or fibrous in appearance.

Ontogeny : Six instars III to VIII were recognised in the present material. The general outline of these instars is similar to that of the adults. However, in the III to VI instars, the greatest height is in the middle.

Ecology/Palaeoecology : The species, incapable of swimming creeps on the muddy and plant rich bottoms of shallow parts of lakes. It also occurs in springs, pools and ponds (Baird, 1838 ; Gurney, 1920 ; Klie, 1938b ; Stephanides, 1948 ; Coope *et al.*, 1962, and Fox, 1965b). Besides fresh-water habitat, the species also inhabits brackish (oligo to polyhaline) environs (Jarvekulg, 1961 and McKenzie, 1964).

The Pleistocene specimens occur in the shallow, fresh-water, lacustrine silts of the Karewas, with rich vegetation, mainly associated with *Cypris pubera* Mueller, *Eucypris* sp. cf. *E. clavata* (Baird), *Candona lactea* Baird, *C. neglecta* Sars and *Ilyocypris bradyi* Sars.

Genus *Heterocypris* Claus, 1892

Heterocypris incongruens (Ramdohr, 1808)
(Pl. VI—5-13)

Remarks : This well-known species of the genus *Heterocypris* Claus, originally described from Europe by Ramdohr (1808), is a very characteristic one. In the Kashmir valley, it extends from the Pleistocene (Up. Karewas) to the Recent. Although the males of the species are known (Klie, 1938b), the specimens in the author's collection are all females.

Ontogeny : Seven instars (II to VIII) have been recognised. The lateral outline of the shell varies from subtriangular in the early intermediate instars to subovate in the late intermediate instars. Similarly the greatest height varies from the anterior half in the former to the posterior half in the latter. The marginal pustules are developed only in the last two instars.

Ecology/Palaeoecology : This species is capable of living in a varied habitat, and in general, is characteristic of small shallow-water bodies. It is found in large numbers in temporary and permanent, natural and artificial ponds, pools of all kinds, flowing muddy ditches, marshes and springs (Gurney, 1920; Holmes, 1937; Klie, 1938b; Jarvekulg, 1959; Stephanides, 1948, 60; and Hagerman, 1967). It is also reported living in temporary and permanent running waters (Holmes, 1937, and Hoff, 1942) and in the rice fields (Fox, 1965a, and Moroni, 1967). Besides the fresh-water environs, the species can also survive in slightly brackish waters, though it is capable of reproducing only in the fresh-water habitat (Klie, 1938b, and Jarvekulg, 1961).

In the Kashmir valley, the species occurs in abundance in stagnant waters of small ponds rich in vegetation, along with *Cypris pubera* Mueller, *Eucypris* sp. cf. *E. clavata* (Baird), *Potamocypris smaragdina* (Vavra), and in the rice fields along with *Stenocypris major* (Baird) and *Ilyocypris bradyi* Sars (Singh, 1973d).

The Pleistocene specimens are found to occur in the lacustrine silt deposits of the valley, mainly in association with *Candona marengoensis* Klie, *Cypris pubera* Mueller, *Eucypris* sp. cf. *E. clavata* (Baird), *Cypridopsis aculeata* (Lilljeborg) and *Ilyocypris bradyi* Sars.

Genus *Isocypris* Mueller, 1908

Isocypris priomena Mueller, 1908
(Pl. VII—1-5)

Remarks : This typical Ethiopian species is the genotype of the genus. It occurs only in the Pleistocene (Up. Karewas) of the Kashmir valley. According to Sars (1924) and Fox (1963), the adults measure up to 1.50 mm. in length. However, the largest specimens

in the author's collections which measure up to 1.20 mm. in length are identified as the VIII instars.

Ontogeny : Only four instars V to VIII have been recognised. The general outline in all these is identical with that of the adult, as illustrated and described by Sars (1924). The finely reticulate structure on the surface, however, is not developed in all the juveniles.

Ecology/Palaeoecology : The species, capable of swimming, is known to inhabit ponds (Sars, 1924). In the Pleistocene fresh-water lake silt deposits rich in vegetation matter, it occurs in association with shallow-water species like *Cypridopsis vidua* (Mueller) and *Ilyocypris bradyi* Sars.

Genus *Stenocypris* Sars, 1889

Stenocypris major (Baird, 1889)
(Pl. VII—6-9)

Remarks : This cosmopolitan species occurs only as living in the Kashmir valley. Typical specimens, measuring up to 1.60 mm. in length and probably representing the VIII instar, occur in the material at hand. Besides its original description from India by Baird (1859), the species has also been reported from other places in India by Klie (1927), Brehm (1950), Hartmann (1964), Bhatia and Khosla (1968), and Bhatia and Singh (1971a). Triebel (1953) and Ferguson (1964, 67) discuss its synonymy.

Ontogeny : Only a few specimens of the late three intermediate instars could be collected from the present material. The latest probably indicating the VIII instar. In general, these are similar to their adults.

Ecology : The species is commonly found in warm shallow-water ponds and lakes (Baird, 1859; Klie, 1933a; Tressler, 1937; Brehm, 1950 and Bhatia and Khosla, 1968). However, it also inhabits clear running water (Bold, 1958) and rice fields (Fox, 1965a, and Moroni, 1967).

In the Kashmir valley, the species is found to occur infrequently in the rice fields in association with abundant *Heterocypris incongruens* (Ramdohr) and *Ilyocypris bradyi* Sars (Singh, 1973d).

Genus *Zonocypris* Mueller, 1898

Zonocypris costata (Vavra, 1897)
(Pl. VII—10)

Remarks : This species, originally described from East Africa, occurs only in the Plio-Pleistocene (Lr. Karewas) of Kashmir. It has also been reported from the Upper Siwaliks (Pleistocene) of India by Bhatia and Khosla (1967).

Ecology/Palaeoecology : According to Klie (1933b, 39) the species seems to inhabit small lakes. In the Kashmir

valley, the Pleistocene specimens occur in association with *Candona lactea* Baird, *C. candida* (Mueller), *C. marengoensis* Klie, and *Darwinula stevensoni* (Brady and Robertson).

Subfamily Cypridopsinae Kaufmann, 1900

Genus *Cypridopsis* Brady, 1867

Cypridopsis aculeata (Lilljeborg, 1853)

(Pl. VII—11-16)

Remarks : This species of the genus *Cypridopsis* Brady can be recognised by its outline, surface pattern and the internal characters. The presence of reversed overlap, however, distinctly distinguishes it from the other species of the genus. It occurs in the Palaearctic as well as Ethiopian zoo-geographical provinces. In the Kashmir valley, the species is known only from the Pleistocene (Up. Karewas).

Ontogeny : Only three instars, VI to VIII, were recognised in the present material. As compared to the adult, their general outline is more triangular, dorsal angulation more conspicuous and the inner list of the right valve closer to the inner margin.

Ecology/Palaeoecology : This species is characteristic of mildly brackish waters, being capable of living even in oligohaline to mesohaline environs. It also commonly occurs in shallow water bodies like pools and marshes. Though it is a good swimmer, it also lives on the bottom sediments (Mueller, 1900 ; Alm, 1915 ; Klie, 1938b ; Stephanides, 1948 ; Kruit, 1955 ; Jarvekulg, 1959 ; and Petkovski, 1964).

In the Kashmir valley, the Pleistocene specimens occur in the fresh-water lacustrine silt deposits rich in vegetation matter, in association with *Candona marengoensis* Klie, *Cypris pubera* Mueller, *Eucypris* sp. cf. *E. clavata* (Baird), *Heterocypris incongruens* (Ramdohr), *Ilyocypris bradyi* Sars and *Limnocythere franki* Bhatia.

Cypridopsis vidua (Mueller 1776)

(Pl. VIII—1-5)

Remarks : This well-known cosmopolitan species was originally described from the Recent of Europe. In the Kashmir valley, it ranges from the Plio-Pleistocene to the Recent.

Ontogeny : Only three instars, VI to VIII, were noted. As compared to the adults, the general outline of these instars is more triangular with greatest height in the anterior half.

Ecology/Palaeoecology : The species is known to inhabit a wide variety of habitat. It is commonly found in permanent still waters with rich aquatic vegetation, like lakes, ponds and ditches. In the lakes, it shuns open waters, preferring the marginal shallow zone with abundant vegetation growth occurring up to depths of the order

of 70 metres with a temperature $\pm 20^{\circ}\text{C}$. It is a very active and powerful swimmer, but prefers muddy bottoms with rich vegetation (Baird, 1838 ; Brady and Norman, 1889 ; Sars, 1925 ; Lowndes, 1931 ; Holmess, 1937 ; Klie, 1937, 38b ; Hoff, 1942, 43a, b ; Stephanides, 1948, 60 ; Kesling, 1951 ; Kruit, 1955 ; Patkovski, 1961 ; Winkler, 1962 ; Staplin, 1963b, Marinov, 1964 ; Akatova and Jarvekulg, 1965 ; and Fox, 1965b, 66b). However, it also occurs commonly in running waters with rich vegetation growth, like streams and canals and back waters of the rivers where some current action persists (Baird, 1838 ; Hoff, 1942 ; and Staplin, 1963b). Though this species is characteristic of fresh water, it can also survive in sub-brackish to brackish conditions (Brady and Norman, 1889 ; Sars, 1925 ; Klie, 1938b ; Kesling, 1951 ; Kruit, 1955 ; and Marinov, 1964).

In the Kashmir valley, the species is reported from clear fresh, slightly alkaline water of lakes with abundant vegetation, mainly in association with candonids (Bhatia and Singh, 1971b). The author has also found it in small numbers in the rice fields (Singh, 1973d).

In the Pleistocene, fresh-water, lake silt deposits of the valley, it occurs commonly in association with assemblages characteristic of shallow to moderate depths.

Genus *Potamocypris* Brady, 1870

Potamocypris minuta patriciae Bhatia, 1968

(Pl. VIII—6-9)

Remarks : This species has originally been described from the Upper Karewas (Pleistocene) of Kashmir by Bhatia (1968b). However, its range in the Kashmir valley extends to the Recent.

Ontogeny : Only a very few specimens of a late intermediate instar could be collected, which resembles with the adult.

Ecology/Palaeoecology : The species lives in lacustrine environs with fresh, cool, slightly alkaline water and abundant vegetation (Bhatia and Singh, 1970a, b, 71b ; and Singh, 1973d). In the Karewas, it occurs abundantly, in association with *Candona lactea* Baird, *Cycloocypris laevis* (Mueller), *Cypria ophthalmica* (Jurine), *Cypridopsis vidua* (Mueller), *Ilyocypris bradyi* Sars, and *Darwinula stevensoni* (Brady and Robertson).

Potamocypris smaragdina (Vavra, 1891)

(Pl. VIII—10-15)

Remarks : This species has originally been described from the Recent, Bohemia by Vavra, 1891. It ranges from the Pleistocene (Up. Karewas) to the Recent, in the Kashmir valley.

Ontogeny : Only a few specimens of its late intermediate instars could be traced. These are similar to the adult.

Ecology/Palaeoecology : The species occurs commonly in permanent water bodies like lakes and also in temporary ponds. In lakes, the species shuns open waters and is found abundantly in the vegetation rich shallower marginal parts (Hoff, 1942, 43a, b and Staplin, 1963b). However, it also lives in the streams (Hoff, 1943a and Staplin, 1963b) and the rice fields (Moroni, 1967).

In the Pleistocene of Illinois, it is found in the shallow lake deposits with moderate vegetation (Staplin, 1963b).

In the Kashmir valley, the species lives in large numbers in foul and stagnant pond waters with rich vegetation growth, in association with *Cypris pubera* Mueller, *Eucypris* sp. cf. *E. clavata* (Baird), *Heterocypris incongruens* (Ramdohr) and *Potamocypris (Cyprilla) staplini* Singh (Singh, 1973d). The Pleistocene specimens occur in the shallow fresh water lacustrine silts of the Karewas, with rich vegetation matter, mainly associated with *Ilyocypris bradyi* Sars.

Subgenus Cyprilla Sars, 1924

Potamocypris (Cyprilla) arcuata (Sars, 1924)

(Pl. VIII—16-17)

Remarks : This typical Ethiopian species was originally described as *Cyprilla arcuata* by Sars (1924), from the Recent of South Africa. However, the author has preferred to assign a subgeneric status to this taxon (Singh, 1971b, 74c). In the Kashmir valley, it occurs only in the Pleistocene (Up. Karewas).

Ecology/Palaeoecology : The species is devoid of swimming power (Sars, 1924). In the Kashmir valley, it occurs in the Pleistocene silt deposits rich in vegetation matter, in association with *Candona lactea* Baird, *C. marengensis* Klie and *Ilyocypris bradyi* Sars.

Potamocypris (Cyprilla) humilis (Sars, 1924)

(Pl. VIII—18-20)

Remarks : This species has been originally described as *Cyprilla humilis* by Sars (1924) from the Recent of South Africa. In the Kashmir valley, it occurs only in the Pleistocene (Up. Karewas).

Ontogeny : Only a few specimens of a late intermediate instar were noticed in the present material. The general outline in these is similar to that of the adult. However, they bear small pustules and spiny nodes all over their lateral surface, which are absent in the adults. This feature has also been mentioned by Purasjoki (1948).

Ecology/Palaeoecology : This species occurs commonly in brackish-water environment (Purasjoki, 1948 and Hagerman, 1967). It was reported inhabiting rocky pools on the sea shore, with profuse algal vegetation growth, in association with *Limnocythere inopinata* Baird and *Cypridopsis aculeata* (Lilljeborg) (Purasjoki, 1948).

In the Kashmir valley, it occurs in very small numbers in the Pleistocene, fresh-water, lacustrine silt deposits

rich in vegetation matter, in association with *Candona lactea* Baird, *C. neglecta* Sars, *Cyclocypris laevis* (Mueller), *Cypridopsis vidua* (Mueller), *Ilyocypris bradyi* Sars and *Iso-cypris priomena* Mueller.

Subfamily Candoninae Daday, 1900

Genus *Candona* Baird, 1845

Candona candida (Mueller, 1776)

(Pl. VIII—21-25)

Remarks : This is a well-known cosmopolitan species. In the Kashmir valley, it is of abundant and wide spread occurrence, ranging from the Plio-Pleistocene to the Recent. The males are very rare in the material. Some of the female specimens show a distinct reticulation in the posterior half, within the shell structure, caused by a fine reticulate chitinous integument (*vide etiam* Sylvester-Bradley, 1941).

Ontogeny : Four instars, V to VIII, were noted. In general outline, they are akin to the adults. However, the dorsal margin of the instars is less prominently raised. In the V instar, the dorsal margin is almost parallel to the ventral margin.

Ecology/Palaeoecology : Though this species is capable of living in highly varied habitats, it prefers clear, fresh, permanent, shallow water bodies with moderate vegetation. It is found commonly in lakes, ponds, pools, ditches, swamps, bogs, and marshes (Brady, 1910 ; Lowndes, 1931 ; Holmes, 1937 ; Klie, 1938b ; Coope *et al.*, 1962 ; Winkler, 1962 ; Staplin, 1963a ; Akatova and Järvekül, 1965 ; and Fox, 1965b, 66a) ; in springs and streams (Brady, 1910 and Klie, 1938b) ; and in the rice fields (Fox, 1965a). According to Klie, (1938b), Jarvekul (1961) and Staplin (1963a), it can also live in slightly brackish waters. It can tolerate a wide temperature variation ranging from arctic to subtropical (Winkler, 1962), and a depth variation from less than 1 metre to as much as 29.5 metres (Akatova and Jarvekul, 1965).

In the Pleistocene of Illinois, it occurs in the fresh-water lacustrine deposits of shallow depths with moderate vegetation (Staplin, 1963a).

In the Kashmir valley, the species was found living in large numbers in lakes with clear, fresh, cool and slightly alkaline water with rich vegetation and also in the flowing channel waters (Bhatia and Singh, 1970a-c, 71b, and Singh 1973d). A single specimen was also collected from the stagnant waters of a small rocky pond (Singh, 1973d). The Pleistocene specimens occur in large numbers in the fresh-water lacustrine silts of the Karewas in a varied association of other species.

Candona compressa (Koch, 1838)

(Pl. VIII—26-28)

Remarks : This typical Holarctic species was originally described from Germany by Koch (1838). In the Kashmir valley it ranges from the Plio-Pleistocene to the Recent.

Ontogeny : Since only two instars were recognised, not much can be said about the ontogeny. However, in general outline, they are all similar to the adult.

Ecology/Palaeoecology : The species lives in the sweet, fresh, permanent waters of lakes preferring sandy bottoms ; occasionally it is also found in the sublittoral parts. It can also live in slightly brackish environment (Klie, 1938b ; Wagner, 1957).

In the Kashmir valley, the species was found only in lacustrine environment (Bhatia and Singh, 1970b, 71b). In the Pleistocene lacustrine silts, it occurs abundantly in association with *Candona marengoensis* Klie, *Cypridopsis aculeata* (Lilljeborg), and *Ilyocypris bradyi* Sars.

Candona fabaeformis (Fischer, 1854)

(Pl. IX—1-5)

Remarks : This typical Holarctic species has been originally described as *Cypris fabaeformis* by Fischer (1854). It occurs in the Plio-Pleistocene of the Kashmir valley, being common to both the Lower and the Upper Karewas. Although the males of the species having a different outline than the females are known (*vide* Brady and Norman, 1889 ; Mueller, 1900 ; and Klie, 1938b), all the specimens in the author's collection are females.

Ontogeny : Only four instars, V to VIII, were noticeable in the material. This general outline is similar to that of the adult, except for the dorsal margin which is more straight and parallel to the ventral.

Ecology/Palaeoecology : The species is known to inhabit shallow waters, being common in muddy pools, ditches, marshes, swamps and in the shallower marginal parts of the lakes (Lowndes, 1931 ; Klie, 1933a, 38b ; and Stephanides, 1948). It can also live in brackish waters (Järvekülg, 1961), and in the rice fields (Moroni, 1967).

In the Kashmir valley, it occurs in the Pleistocene, fresh-water, lacustrine silts of the Karewas containing abundant molluscan fauna and vegetation matter, in association with *Candona lactea* Baird, *C. canaida* (Mueller), *C. marengoensis* Klie, *Ilyocypris bradyi* Sars and *I. gibba* (Ramdohr).

Candona sp. cf. *C. havanaensis* Staplin, 1963

(Pl. IX—6-7)

Remarks : Except for the slight differences in lateral outline, the species is close to the female of *Candona havanaensis* Staplin (*vide* Dr. F.L. Staplin, personal communication). It is of a very restricted occurrence in the Kashmir valley being found only in the Pleistocene (Up. Karewas).

Palaeoecology : The species was originally described from the permanent, cool, alkaline, lake deposits of Illinois, U.S.A. (Staplin, 1963a). In the Kashmir valley, it occurs in the Pleistocene fresh-water lacustrine silts, in association with large numbers of *Candona lactea* Baird,

C. marengoensis Klie, *C. neglecta* Sars, *Ilyocypris bradyi* Sars and small numbers of *Darwinula stevensoni* (Brady and Robertson) and *Cytherissa lacustris* (Sars).

Candona lactea Baird, 1850

(Pl. IX—8-10)

Remarks : This species, originally described by Baird (1850) from England, is characterised by its subreniform or been-shaped lateral outline. The species seems very close to the juveniles of *Candona candida* (Mueller) of similar size range ; it can, however, be distinguished by its evenly rounded anterior and posterior margins. It is of abundant and wide-spread occurrence in the Kashmir valley, ranging from the Plio-Pleistocene to the Recent.

Ontogeny : Only two instars, VII and VIII, were recognised. In general outline they are similar to the adult. In the absence of the remaining instars, nothing further can be said about the ontogeny of this species.

Ecology/Palaeoecology : *Candona lactea* Baird is in general a cold-hardy species (Staplin, 1963a). Though it is a fresh-water species, it is also reported from polyhaline waters (McKenzie, 1964).

In the Kashmir valley, it has been reported living in the fresh, clear, alkaline waters of the lakes (Bhatia and Singh, 1970a-c, 71b and Singh, 1973d). It is of a wide-spread occurrence in the Pleistocene, fresh-water, lacustrine silts of the valley, in a varied association of other ostracode species.

Candona marengoensis Klie, 1931

(Pl. IX—11-15)

Remarks : This Nearctic species originally described by Klie (1931) from U.S.A. can be easily identified by its characteristic subquadrate lateral outline, pitted, reticulate surface and narrow to moderately wide inner lamella. The species shows closeness to *Candona rostrata* Brady and Norman (1889), but differs from it by its smaller size and slightly different lateral and dorsal outlines. It is of a wide-spread occurrence in the Kashmir valley, ranging from the Plio-Pleistocene to the Recent.

Ontogeny : Only four instars, V to VIII, were noted. Their outline is similar to that of the adults, except for the dorsal margin which is straight and horizontal.

Ecology/Palaeoecology : Although the species can tolerate a wide range of environments, it is characteristic of shallow depths in permanent still waters with moderate vegetation (Staplin, 1963a). In the Kashmir valley, the species was reported, though in small numbers, from the clear, fresh, cool, alkaline lake waters with rich vegetation growth, occurring in association with large numbers of *Candona canaida* (Mueller), *C. lactea* Baird, *C. neglecta* Sars and *Cypridopsis vidua* (Mueller) (Bhatia and Singh 1970b, 71b). The Pleistocene specimens occur in the

fresh-water, lacustrine silts of the Karewas with rich vegetation matter.

Candona neglecta Sars, 1887

(Pl. IX—16-20 ; Pl. X—1-2)

Remarks : This is a well-known Palaearctic species. It occurs abundantly in the Kashmir valley, ranging from the Plio-Pleistocene to the Recent.

Ontogeny : Four instars, V to VIII, were recognised. In general outline, the instars VII and VIII are akin to the adults and even the males and females can be easily distinguished. Some female specimens of the VIII instar show a distinct reticulate pattern in the anterior, posterior and ventral parts. The V and VI instars are reniform or bean shaped with anterior and posterior margins more or less equally rounded.

Ecology/Palaeoecology : The species is found in varying habitats being common in shallow parts of lakes, muddy ponds, pools, ditches and spring waters (Lowndes, 1931 ; Holmes, 1937 ; Stephanides, 1948 ; Akatova and Jarvekulg, 1965 ; Fox, 1965b ; and Hagerman, 1967). Though it is a fresh-water species, it also extends into slightly brackish waters (Klie, 1938b ; Elofson, 1943 ; Marinov, 1964) and even polyhaline waters (McKenzie, 1964).

In the Kashmir valley, the species was found to be living in the clear, cool, fresh alkaline lake waters with abundant vegetation, mainly in association with other candonids (Bhatia and Singh 1970a-c, 71b and Singh, 1973d). In addition, it is also observed to be inhabiting abundantly the flowing clear, cold, spring water and the rice fields ; and scarcely a permanent stagnant rocky pond (Singh, 1973d). The Pleistocene specimens occur in varying associations, indicating diverse habitats.

Candona sp. cf. *C. pearlensis* Staplin, 1963

(Pl. X—3)

Remarks : The specimens in the present material are close to the females of *Candona pearlensis* Staplin, originally described from the Pleistocene of U.S.A. It is found to occur only in the Pleistocene (Up. Karewas) of the Kashmir valley.

Palaeoecology : The species is inferred to inhabit permanent lakes with alkaline waters and moderate vegetation (Staplin, 1963a). In the Pleistocene, lacustrine, fresh-water silts of the Karewas, it occurs in association with *Candona lactea* Baird and *Candona neglecta* Sars.

Candona rawsoni Tressler, 1957

(Pl. X—4-5)

Remarks : This is a typical Holarctic species. Though the female left valve is very characteristic because of the posterior truncation, the right valve, however, is close to the female of *Candona candida* (Mueller), from which, however, it can be distinguished by its slightly different

lateral and dorsal outlines. A distinct dimorphism in the species is known (Delorme, 1968), however, only females were found in the author's collections. Regarding distribution in the Kashmir valley, the species is of a restricted occurrence, found only in the Pleistocene (Up. Karewas).

Ecology/Palaeoecology : The species occurs in lakes with fresh, alkaline, cold waters, commonly at depths varying from 11 to 37 metres (Tressler, 1957 ; Staplin, 1963a ; and Delorme, 1967). The species also lives in permanent and temporary mountainous ponds, at depths of the order of 5 feet, with T.D.S. varying from 165 to 6805 ppm ; in the bigger lakes it may occur at depths as high as 104 metres (Delorme, 1969). It can also survive a torpid state (Delorme and Donald, 1969). In the Pleistocene of U.S.A., it occurs in abundance in the terrace silts, lake silts and clays and in deposits formed by ice damming, in association with cold water species. In the Pleistocene deposits of Canada, it occurs below the *Cytherissa lacustris* zone (Delorme, 1968).

In the Pleistocene, fresh-water lacustrine silts of the Karewas, it occurs in association with *Candona lactea* Baird, *C. neglecta* Sars, *Herpetocypris reptans* (Baird) ,and *Ilyocypris bradyi* Sars.

Candona sp. cf. *C. stammeri* Klie, 1938

(Pl. X—6)

Remarks : This species is comparable with *Candona stammeri* Klie, originally described from the Recent of Italy ; however, differing by its slightly larger size. In the Kashmir valley, the species occurs only in the Pleistocene (Up. Karewas).

Ecology/Palaeoecology : Very little is known about the ecology/Palaeoecology of this species, since it is of a very limited distribution. It was originally described from the subterranean water bodies like caves and wells with slightly brackish-waters (Klie, 1938a). It occurs, though very scarcely, in the fresh-water lacustrine silts of the Upper Karewas of the Kashmir valley, in association with moderate to deep water assemblage comprising *Candona candida* (Mueller), *C. compressa* (Koch), *C. lactea* (Baird), *C. marengoensis* (Klie), *C. neglecta* Sars, *Cypridopsis vidua* (Mueller), *Darwinula stevensoni* (Brady and Robertson), *Ilyocypris bradyi* Sars, *I. shawneetownensis* Staplin and *Potamocypris minuta patriciae* Bhatia.

Genus *Candonopsis* Vavra, 1891

Candonopsis kingsleii (Brady and Robertson, 1870)

(Pl. X—7-10)

Remarks : This species, the genotype for the genus, was originally described from the Recent, England. It is a well-known Palaearctic species. In the Kashmir valley, it ranges from the Pleistocene (Up. Karewas) to the Recent.

Ontogeny : Three instars, VI to VIII, were recognised in the present material. The VIII instar is akin to the adult in general outline and inner features. However, the VI and VII instars are more reniform or bean-shaped with inner lamella curved anteriorly, instead of being partly straight as in the VIII instar and the adult.

Ecology/Palaeoecology : This species is commonly found in permanent, small, fresh-water bodies and lakes with rich vegetation, in the weedy margin of shallow, boggy ponds and marshes (Lowndes, 1931 ; Klie, 1938b ; Stephanides, 1948 ; and Fox, 1965b, 66b). It also occurs in brackish waters (Marinov, 1964).

In Kashmir valley, it was found in deep water Manasbal lake, in association with large numbers of *Candona candida* (Mueller), *C. lactea* Baird and *Cypridopsis vidua* (Mueller) (Bhatia and Singh, 1971b and Singh (1973d).

The Pleistocene specimens occur in fresh-water lake silts of the Karewas, in association with *Candona candida* (Mueller), *C. lactea* Baird, *C. neglecta* Sars, *Ilyocypris bradyi* Sars and *Darwinula stevensoni* (Brady and Robertson).

Family Cyclocyprididae Kaufmann, 1900

Genus *Cyclocypris* Brady and Norman, 1889

Cyclocypris laevis (Mueller, 1785)

(Pl. X—11-12)

Remarks : This typical Holarctic species is similar to *Cyclocypris laevis* (Mueller) in all respects but for the presence of a reversed overlap. In the present material, right valve is the larger valve whereas normally the left valve is larger (Wagner, 1957 and Staplin, 1963b). It is another example of reversal of overlap within the same species. In the Kashmir valley the species ranges from the Plio-Pleistocene to the Recent.

Ecology/Palaeoecology : This species, an active swimmer, is capable of living in a varied habitat. It is found commonly in shallow weedy ponds, pools and also lakes (Lowndes, 1931 ; Holmes, 1937 ; Staplin, 1963b ; and Hagerman, 1967). It can stand even freezing temperatures (Korschelt, 1914 in Kesling, 1951). Though it is commonly a fresh-water species, it can also live in brackish-waters of low salinity (Klie, 1938b ; Jarvekulg, 1961 ; Staplin, 1963b and Hagerman, 1967).

In the Kashmir valley, it occurs in the shallow, fresh, slightly alkaline, lake and channel waters with rich vegetation (Bhatia and Singh (1970a-c, 71b). However, it also occurs in small numbers in flowing, cold, fresh spring water with abundant vegetation, in association with large numbers of *Candona neglecta* Sars and *Parastenoicypris delormeii* Singh (Singh, 1973d).

The Pleistocene specimens occur in the silty lake deposits of the Karewas, in association with *Candona lactea*

Baird, *C. neglecta* Sars, *Cypridopsis vidua* (Mueller), *Cypria ophthalmica* (Jurine) and *Ilyocypris bradyi* Sars.

Cyclocypris ovum (Jurine, 1820)

(Pl. X—13)

Remarks : This Holarctic species is close to *Cyclocypris laevis* (Mueller) ; however, differing from it by its shorter height and a more ovate lateral outline. In the Kashmir valley, it occurs only in the Pleistocene (Up. Karewas).

Ecology/Palaeoecology : The species can tolerate a varied habitat except for very deep or acidic waters. It commonly lives in ponds, and lakes with rich vegetation and marshes (Furtos, 1933 ; Stephanides, 1948 ; Straub, 1952 ; and Akatova and Järvekulg, 1965). It is also found occasionally living in cold streams (Furtos, 1933). Besides fresh waters it also occurs in brackish waters (Straub, 1952).

In the fresh-water lake silts of the Karewas, it occurs in small numbers in association with *Candona lactea* Baird, *C. neglecta* Sars, *Ilyocypris bradyi* Sars and *Darwinula stevensoni* (Brady and Robertson).

Genus *Cypria* Zenker, 1854

Cypria ophthalmica (Jurine, 1820)

(Pl. X—14-20)

Remarks : This is a cosmopolitan species, originally described from the Central Europe. In the Kashmir valley, it ranges from the Pleistocene (Up. Karewas) to the Recent.

Ontogeny : Only three instars, VI to VIII, could be recognised in the present material. In general outline, they are similar to the adult, except for the greatest height being more distinctly in the anterior half.

Ecology/Palaeoecology : This species is a fast swimmer and lives in a highly varied environment. It is of common occurrence in still, shallow waters of pools, ponds, ditches, wells, lakes, bogs, swamps and marshes (Baird, 1838 ; Brady and Norman, 1889 ; Lowndes, 1931 ; Holmes, 1937 ; Klie, 1938b ; Wagner, 1957 ; Dobbin, 1941 ; Hoff, 1942 ; Stephanides, 1948 ; Straub, 1952 ; and Fox, 1965b, 66b). Besides the fresh waters, the species is also very common in mild to oligohaline waters (Brady and Norman, 1889 ; Hagerman, 1967 ; Klie, 1938b ; Straub, 1952 and Wagner, 1957).

In the Kashmir valley, the species was found in small numbers in fresh-water lakes, at depths ranging up to 25 feet (Bhatia and Singh, 1971b and Singh, 1973d) and also in the cold fresh, spring water, where only a single specimen of a juvenile could be collected (Singh, 1973d).

The Pleistocene specimens occur in the fresh-water lacustrine, silts of the Karewas, in large numbers, mainly in association with *Candona lactea* Baird, *C. neglecta* Sars,

Cyclocypris laevis (Mueller), *Cypridopsis vidua* (Mueller) and *Ilyocypris bradyi* Sars.

Family Ilyocyprididae Kaufmann, 1900

Subfamily Ilyocypridinae Kaufmann, 1900,

Genus *Ilyocypris* Brady and Norman, 1889

Ilyocypris Bradyi Sars, 1890

(Pl. XI-1-8)

Remarks : This species has originally been described by Sars (1890) from Norway. It shows considerable variation in its surface ornamentation (intensity of pitting), and in the number and location of pustules. It is interesting to note that a number of specimens from the same sample, from the Karewas, show nodes of varying intensity. These specimens show a gradation towards *Ilyocypris gibba* (Ramdohr). This indicates that the two species, viz., *Ilyocypris bradyi* Sars and *I. gibba* (Ramdohr) may be conspecific. The species ranges from the Pleistocene (Up. Karewas) to the Recent in the Kashmir valley.

Ontogeny : Six instars, III to VIII, were recognised in the material at hand. The general outline of these instars is same as in the adults. In the III - V instars, ventral margin is gently convex and the anterior margin much broader than the posterior; also the number of marginal pustules is very few. The shell surface in these early intermediate instars and also in the highly matured adults is faintly pitted.

Ecology/Palaeoecology : This species, incapable of swimming, is characteristic of temporary and permanent running waters with rich vegetation (Holmes, 1937; Hoff, 1942; Petkovski, 1958 and Staplin, 1963b). However, it also commonly occurs in shallow water bodies like pools, ponds, ditches, springs, marshes and less commonly in lakes (Gurney, 1920; Holmes, 1937; Hoff, 1942; Stephanides, 1948; Petkovski, 1958; Coope *et al.* 1962; Staplin, 1963b and Fox, 1967). Besides the above given habitats, it is also found inhabiting the rice fields (Moroni, 1967). Though it is a fresh-water species, it also occurs in brackish waters (Marinov, 1964). It is a very common associate of *Ilyocypris gibba* (Ramdohr) and *Heterocypris incongruens* (Ramdohr).

Staplin (1963b) reports the occurrence of the species in the Pleistocene, slack-water deposits where current action is indicated.

In the Kashmir valley, the species was found in very large numbers in the rice fields in association with large numbers of *Heterocypris incongruens* (Ramdohr) and rare in the sluggishly flowing cold spring waters (Singh, 1973d).

The Pleistocene specimens occur widely in the fresh-water, lake deposits of the Karewas of the valley.

occurring frequently in association with *Ilyocypris gibba* (Ramdohr).

Ilyocypris gibba (Ramdohr 1808)

(Pl. XI-9-14)

Remarks : This species, genotype for the genus, was originally described by Ramdohr (1808) from Europe. Except for the presence of two distinct nodes on the lateral surface, the species, in all other respects, is similar to *Ilyocypris bradyi* Sars. It ranges from the Plio-Pleistocene to the Recent in the Kashmir valley.

Ontogeny : In all, five instars, IV to VIII, were recognised in the present material. In general outline these are akin to the adult. However, in the IV and V instars, the anterior is much broader than the posterior and the dorsal margin more straight. In the IV-VI instars, the shell surface is faintly pitted. The number of spines is fewer in the early intermediate instars, increasing gradually in the later ones.

Ecology/Palaeoecology : The species is characteristic of temporary and permanent running waters with sufficient current action (Hoff, 1942; Staplin, 1963b). However, it also inhabits shallow water bodies like rain water pools, permanent ponds, ditches with muddy bottoms and lakes (Holmes, 1937; Klic, 1938b; Hoff, 1942; Stephanides, 1948, 60; Straub, 1952; Petkovski, 1958, 61; Coope *et al.*, 1962; Staplin, 1963b; and Fox, 1966b). The species has also been reported from the rice fields (Fox, 1965a, 66b and Moroni, 1967). Though it is a fresh water species, it also extends into mildly brackish (Klic, 1938b, Fox, 1967) and at times even in polyhaline waters (McKenzie, 1964). The species commonly lives at temperatures varying from 5°C to 25°C, but can also survive extremes of temperatures (-10°C to 43°C) (Margalef, 1947). It commonly lives in association with *Ilyocypris bradyi* and *Heterocypris incongruens* (Ramdohr) (Holmes, 1937 and Hoff, 1942).

In the Pleistocene, fresh-water lake deposits of the Kashmir valley, it commonly occurs in small numbers. Wherever abundant, it occurs in association with large numbers of *Candona lactea* Baird, *C. neglecta* Sars, *Ilyocypris bradyi* Sars, and small numbers of *Darwinula stevensoni* (Brady and Robertson) and *Cytherissa lacustris* (Sars).

Ilyocypris shawneetowenensis Staplin, 1963

(Pl. XI-15-21)

Remarks . This species, originally described by Staplin (1963b) from the Pleistocene of Illinois, U.S.A., is a very characteristic one because of its typical surface features. Kempf (1967) described a similar species, *Ilyocypris stegeri* Kempf, from the Holocene-Interglacials of Tonisberg, Germany, which is here considered to be conspecific with *Ilyocypris shawneetowenensis* Staplin (*vide etiam* Kempf, 1967, p. 133). The species *Ilyocypris shawneetowenensis*

Staplin ranges from the Pleistocene (Up. Karewas) to the Recent, in the Kashmir valley.

Ontogeny : In all, five instars, III, V to VIII, were noticeable in the material. These, in general outline, are similar to the adults. The postero-dorsal lobe in the III and V to VII instars, bears a small node which is absent in the adult. The number of spines in the early intermediate instars is fewer, gradually increasing in the later ones.

Ecology/Palaeoecology : Staplin (1963b) opined that the species is characteristic of slack-water deposits, perhaps in an environment of a sluggish, weedy tributary bounded at frequent intervals.

In the Kashmir valley, Bhatia and Singh (1971b) reported this species from the Dal lake, with fresh, shallow, slightly alkaline waters and abundant vegetation growth. The presence of this species in the northern part of this lake is attributed to the presence of a small sluggish tributary flowing into the lake from the north.

In the Karewa silts, the species was found to be occurring in association with large numbers of *Candona candida* (Mueller), *C. lactea* Baird, *C. neglecta* Sars, *Cytherissa lacustris* (Sars), and *Ilyocypris bradyi* Sars, which probably are indicative of shallow to moderately deep lacustrine environment with current action.

Superfamily Darwinulacea Brady and Norman, 1889
Family Darwinulidae Brady and Norman, 1889
Genus *Darwinula* Brady and Robertson, 1885
Darwinula stevensoni (Brady and Robertson, 1870)
 (Pl. XI- 22-25)

Remarks : This cosmopolitan species, genotype for the genus, has originally been described from the Recent of the British Isles. Though dimorphism in this species is known (*vide* Brady and Robertson, 1870 ; Brady and Norman, 1889 ; and Turner, 1895), there is no evidence of it in the material at hand, all the specimens being apparently females. In the Kashmir valley, the species ranges from the Plio-Pleistocene to the Recent.

Ontogeny : Only three instars, VI to VIII, could be noticed, which in general outline are similar to the adult. Since the other intermediate instars could not be collected, much can not be said about its ontogeny.

Ecology/Palaeoecology : The species is known to inhabit varying habitats. Though it is chiefly found in large permanent lakes at depths ± 10 metres, it also occurs in the shallow permanent water pools ; being incapable to swim, it crawls on the muddy and sandy bottom sediment with rich vegetation matter (Brady and Robertson, 1870 ; Brady and Norman, 1889 ; Turner, 1895 ; Sars, 1925 ; Lowndes, 1931 ; Klic, 1933a, 38b ; Holmes, 1937 ; Hoff, 1942 ; Straub, 1952 ; Järvekülg, 1959 ; Petkovski, 1961 ; and Fox, 1965b, 66b). Although Hoff (1942)

states that it is a characteristic species of still waters with absolutely no current action, there are, however, reports of the species from rivers, streams and canals (Brady and Norman, 1889 ; Straub, 1952 ; and Bold, 1958). Besides being found in sweet fresh-waters, it is also capable of living in brackish (Obligo to mesohaline) waters (Sars, 1925 ; Marinov, 1964 ; and Hagerman, 1967). According to Delorme (1964) the species can tolerate total dissolved solids up to a maximum of 175 ppm.

Regarding its palaeoecology, the species has been reported from the brackish-water molasse (Post-Tertiary) of Germany. Staplin (1963b), reporting the species from the Pleistocene, lacustrine deposits of Illinois, U.S.A., remarks about its presence in large lake and shallow water deposits, commonly associated with *Candona swaini* (= *Candona rawsoni* Tressler), *Cytherissa lacustris* (Sars) and several species of *Limnocythere* Brady.

In the Recent of Kashmir valley, the species is exceedingly rare in the deep-water Manasbal lake (*vide* Bhatia and Singh, 1971b).

The Pleistocene specimens occur in the fresh-water, lacustrine silts of the Karewas, with abundant vegetation matter, associated with *Candona lactea* Baird, *C. neglecta* Sars, *Cytherissa lacustris* (Sars) and *Limnocythere franki* Bhatia.

Superfamily Cytheracea Baird, 1850
Family Cytherideidae Sars, 1925
Subfamily Neocytherideidinae Puri, 1957
Genus *Cytherissa* Sars, 1925

Cytherissa lacustris (Sars, 1863)
 (Pl. XI—26-29)

Remarks : Only juveniles of this typical Holarctic species, originally described from the Recent of Norway, by Sars (1863), could be collected. The largest specimens in the author's collection, measuring in length from 0.70 to 0.73 mm., are the higher juveniles and typical of the species (*vide* Dr. L. D. Delorme, personal communication). The adults measure as much as 0.89 to 0.94 mm. in length (*vide* Staplin, 1963b, and Delorme, 1968). The presence of nodes of varying size and number, is a phenotypic character, which is controlled by the variations, in temperature (*vide* Sylvester-Bradley, 1965, in Shotton and Osborne). In the Kashmir valley, the species occurs in the Plio-Pleistocene, being common to both the Lower and the Upper Karewas.

Ontogeny : Only four instars, V to VIII, were recognised in the present material, which in general outline are akin to the adult. In the instars V to VII, besides the prominent nodes on either side of the dorsal sulcus, a number of additional nodes and lobes of varying sizes are also developed.

Ecology/Palaeoecology : *Cytherissa lacustris* (Sars) is generally characteristic of large and deep fresh-water lakes, though it may also sometimes be found in the shallow littoral zones (Klie, 1938b ; Staplin, 1963b ; Akatova and Järvekülg, 1965 ; and Sylvester-Bradley, 1965 in Shotton and Osborne). However, there are also records of this species from canal waters (Brady, 1868). Besides fresh-water, the species can also live in lakes of low salinity (Delorme, 1969). In the lakes of U.S.S.R., it has been reported living even at depths as low as 2.8 metres and as much as 105 metres (Akatova and Järvekülg, 1955).

In the Pleistocene deposits of the Lake Michigan Basin, U.S.A., it occurs in association with *Candona rawsoni* Tressler, *C. sp. cf. C. lactea* Baird, and *Limnocythere friabilis* Benson and MacDonald (Staplin, 1963b).

In the Pleistocene of the Kashmir valley, it occurs in the fresh-water lake silts of the Karewas in association with *Candona lactea* Baird, *C. neglecta* Sars, *Darwinula stevensoni* (Brady and Robertson) and *Ilyocypris bradyi* Sars.

Family Limnocytheridae Klie, 1938

Genus *Limnocythere* Brady, 1868

Limnocythere blankenbergensis Diebel, 1968

(Pl. XII—1-3)

Remarks : This species has, originally, been described from the Pleistocene of Germany, by Diebel (1968). In the Kashmir valley also, it occurs only in the Pleistocene (Up. Karewas).

Ontogeny : Since only two late intermediate instars were noticeable in the material, much about the ontogeny can not be said. Their general outline is similar to that of the adult, but for the slightly sinuate dorsal margin. Moreover, the earlier instar shows the development of a prominent postero-median curved lobe extending into the ventromedian and mid-ventral areas. These instars also lack the reticulate pitting present in the adult.

Palaeoecology : The species occurs in the Pleistocene, fresh-water, lacustrine silts of the Karewas, in association with species of shallower depths, mainly *Candona candida* (Mueller), *C. lactea* Baird, *C. neglecta* Sars, *Ilyocypris bradyi* Sars and *Limnocythere franki* Bhatia.

Limnocythere franki Bhatia, 1968

(Pl. XII—4-11)

Remarks : This distinctive species was originally described from the Upper Karewas by Bhatia (1968b). There is no doubt that specimens figured as *Limnocythere sp.* by Bhatia (1968b), are the males of this species. Besides the specimens with a distinct, large hollow postero-ventral spine, those with smooth surface are also noticed in the present material. The species occurs in the Plio-Pleisto-

cene of the Kashmir valley, being common to both the Lower as well as the Upper Karewas.

Ontogeny : Four instars, V to VIII, were recognised in the material. In general outline, the instars VII to VIII are akin to the adult and the males and females are distinguishable. However, in the V to VI instars, it is difficult to determine dimorphism.

Palaeoecology : The species occurs widely in the Pleistocene, fresh-water lake silts with abundant vegetation matter, in association with species of shallow to moderate depths, mainly *Candona lactea* Baird, *C. neglecta* Sars, *Cypridopsis vidua* (Mueller), *Darwinula stevensoni* (Brady and Robertson), *Ilyocypris bradyi* Sars and *Isocypris priomena* Mueller.

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REFERENCES

- AKATOVA, N. A. and JÄRVEKÜLG, A. A. 1965. *Fauna of the lakes of Karelia (Invertebrates)*. Nauka Publishing House, Moscow, U.S.S.R.
- ALM, G. 1915. Monographie der Schwedischen Suswasser Ostracoden nebst systematischen Besprechungen der Tribus Podocopa. *Zool. Bidr. Uppsala*. **4** : 1-247.
- BAIRD, W. 1835. List of Entomostraca found in Berwickshire. *Proc. Berwick. Nat. Club (Hist.)* 95-100.
- BAIRD, W. 1838. The natural history of the British Entomostraca. *Mag. Zool. Bot.* **2** : 132-144.

- BAIRD, W. 1850. Description of several new species of Entomostraca. *Proc. Zool. Soc. London*. pt. **18** : 254-257.
- BAIRD, W. 1859. Description of some new recent Entomostraca from Nagpur, collected by the Rev. S. Hislop. *Proc. Zool. Soc. London*. pt. **27** : 231-234.
- BHATIA, S. B. 1968a. First record of Ostracodes from the Upper Karewas of Kashmir. *Proc. Indian Sci. Congr.* (Abstr.) pt. **3** : 235-36.
- BHATIA, S. B. 1968b. Pleistocene ostracodes from the upper Karewas of Kashmir, India. *Micropaleontology*. **14**(4) : 465-483.
- BHATIA, S. B. 1969. Some Ostracodes from the Lower Karewas near Nichahom, Kashmir. *Bull. Indian Geol. Assoc.* **2**(1-2) : 69.
- BHATIA, S. B. 1970. *Limnocythere franki*, new name for *Limnocythere staplini* Bhatia, 1968. *Micropaleontology*. **16**(2) : 226.
- BHATIA, S. B. and KHOSLA, S. C. 1967. A preliminary note on the discovery of Ostracodes from the Upper Siwaliks, near Chandigarh. *Bull. Geol. Soc. India*. **4**(1) : 8-11.
- BHATIA, S. B. and KHOSLA, S. C. 1968. Recent Freshwater Ostracodes from Shri Kolayat Ji District Bikaner, Rajasthan. *Proc. Indian Sci. Congr.* (Abstracts). pt. **3** : 236.
- BHATIA, S. B. and SINGH, D. 1970a. First record of Recent freshwater Ostracodes from the Kashmir valley. I Dal lake and Nagin lake. *Proc. Indian Sci. Congr.* (Abstracts). pt. **3** : 198.
- BHATIA, S. B. and SINGH, D. 1970b. First record of Recent freshwater Ostracodes from the Kashmir Valley. II Manasbal lake. *Proc. Indian Sci. Congr.* (Abstracts). pt. **3** : 200.
- BHATIA, S. B. and SINGH, D. 1970c. A note on some Recent Ostracodes from the Dal Lake, Kashmir. *Res. Bull. Panjab Univ., Chandigarh*. **21** (I-III) : 257-259.
- BHATIA, S. B. and SINGH, D. 1971a. Some late Pleistocene Ostracodes from near Garhshanker, District Hoshiarpur, Panjab. *Proc. Indian Sci. Congr.* (Abstracts) pt. **3** 310.
- BHATIA, S. B. and SINGH, D. 1971b. Ecology and Distribution of some Recent Ostracodes of the vale of Kashmir, India. *Micropaleontology*. **17**(2) : 214-220.
- BOLD, W. A. VAN DEN. 1958. Distribution of freshwater Ostracodes in Trinidad. *Micropaleontology*. **4**(1) : 71-74.
- BRADY, G. S. 1868. A monograph of the Recent British Ostracoda. *Trans. Linn. Soc. London*. **26**(2) : 353-495.
- BRADY, G. S. 1910. A revision of the British species of ostracod Crustacea belonging to the sub-families Candoninae and Herpetocypridinae. *Proc. Zool. Soc. London*. pt. **1** : 194-220.
- BRADY, G. S. and NORMAN, A. M. 1889. A monograph of the marine and fresh-water Ostracoda of the north Atlantic, and of north-western Europe, Section I.—Podoopa. *Sci. Trans. Roy. Dublin Soc. ser. 2* : **4**(2) : 63-270.
- BRADY, G. S. and Robertson, D. 1870. The Ostracoda and Foraminifera of tidal rivers, with an analysis and descriptions of the Foraminifera by H. B. Brady. *Ann. Mag. Nat. Hist. ser. 4*, **6** : 1-33.
- BREHM, V. 1950. Contributions to the freshwater fauna of India. *Rec. Indian Mus.* **48**(1) : 1-8.
- COOPE, G. R. SHOTTON, F. W. and STRACHEN, I. 1962. A late Pleistocene fauna and flora from Upton Werren, Worcestershire. *Phil. Trans. Roy. Soc. London. ser. B*. **244** : 379-421.
- DELORME, L. D. 1964. A checklist of Pleistocene and Recent freshwater Ostracods in Canada. *Sterkiana*. **14** : 39-44.
- DELORME, L. D. 1967. Freshwater Ostracode Synonyms. *Jour Paleont.* **41**(3) : 792-794.
- DELORME, L. D. 1968. Pleistocene freshwater Ostracoda from Yukon, Canada. *Canadian Jour. Zool.* **46**(5) : 859-876.
- DELORME, L. D. 1969. Ostracodes as Quarternary paleoecological indicators. *Canadian Jour. Earth Sci.* **6**(6) : 1471-1476.
- DELORME, L. D. and DONALD, D. 1969. Torpidity of fresh-water Ostracodes. *Canadian Jour. Zool.* **47**(5) : 997-999.
- DIEBEL, K. 1968. Neue *Limnocythere*-Arten (Ostracoda) aus dem deutschen Pleistozän. *Monatsberichte*. **10**(7) : 519-538.
- DIBEL, K. and PIETRZENIUK, E. 1969. Ostracoden aus dem Mittelpleistozän von süßenborn bei Weimar. *Paläontol. Abhandl. Abteil. Paläozool.* **III**(3)4 : 463-488.
- DOBRIN, C. N. 1941. Freshwater Ostracoda from Washington and other western localities. *Univ. Washington Publ. Biol.* **4**(3) : 175-246.
- EDMONDSON, W. T., Ed. 1959. *Fresh-water biology* by H. N. Ward and G. C. Whipple. John Wiley and Sons, New York.
- ELOFSON, O. 1943. Neuere Beobachtungen über die Verbreitung der Ostracoden an den skandinavischen Küsten. *Arkiv. Zool.*, **35A**(2) : 1-26.
- FERGUSON, E. JR. 1964. Stenocyprinae, a new subfamily of fresh water cyprid Ostracods (Crustacea) with description of a new species from California. *Proc. Biol. Soc. Washington*. **77** : 17-24.
- FERGUSON, E. JR. 1967. *The type species of the genus Stenocypris Sars 1889 with descriptions of two new species*. Symposium on the Taxonomy, Morphology and Ecology of Recent Ostracoda, Hull Univ., Hull, Yorkshire, England.
- FISCHER, S. 1854. Abhandlung über das Genus *Cypris*, and dessen in der Umgebung von St. Petersburg und von Fall bei Reval vorkommen den Arten. *Mem. Savant. Etrangrs.* **7** : 129-167.
- FOX, H. M. 1963. A new species of *Isocypris* (Crustacea, Ostracoda) from the Lago Maggiore and a new subspecies from rice fields in Piedmont. *Mem. Ist. Ital. Idrobiol.* **16** : 127-136.
- FOX, H. M. 1965a. Ostracod Crustacea from rice fields in Italy. *Mem. Ist. Ital. Idrobiol.* **18** : 205-214.
- FOX, H. M. 1965b. The Ostracoda of the Lago Maggiore. *Mem. Ist. Ital. Idrobiol.* **19** : 81-89.
- FOX, H. M. 1966a. Les Ostracodes deau douce des environs d'Arcachon. *Bull. Soc. Zool. France*. **91**(4) : 773-779.
- FOX, H. M. 1966b. Ostracods from the environs of Pallanza. *Mem. Ist. Ital. Idrobiol.* **20** : 25-39.
- FOX, H. M. 1967. More New and interesting cyprids (Crustacea, Ostracoda) in Britain. *Jour. Nat. Hist.* **4** : 549-559.
- FURTOS, N. C. 1933. The Ostracoda of Ohio. *Bull. Ohio Biol. Surv.* **29**(5) : 412-524.
- GURNEY, R. 1920. List of Entomostraca collected in Seistan and Baluch desert. *Rec. Indian Mus.* **18**(3) : 145-146.
- HAGERMAN, I. 1967. Ostracods of the Tvärmine area, Gulf of Finland. *Commen. Biol. Soc. Sci. Fennica*. **30**(2) : 1-12.
- HARTMANN, G. 1964. *Asiatische Ostracoden. Systematische und Zoogeographische Untersuchungen*. Akademie-verlag, Berlin.
- HOFF, C. C. 1942. *The Ostracods of Illinois (Their biology and Taxonomy)*. Univ. of Illinois, Urbana.
- HOFF, C. C. 1943a. The cladocera and ostracoda of Reelfoot lake. *Jour. Tennessee Acad. Sci.* **18**(1) : 49-107.
- HOFF, C. C. 1943b. *The description of a new ostracod of the genus Potamocypris from Grand Isle, Louisiana, and records of ostracods from Mississippi and Louisiana*. Louisiana State Univ. Occasional papers of the marine laboratory.
- HOLMES, P. F. 1937. Ostracoda from Lake Ohrid. *Archiv. Hydrobiol.* **31** : 484-500.
- JÄRVERKÜLG, A. 1959. Andmeid Eesti Magevete Karpvähiliste (Ostracoda) Fauna Kohta. *Eesti NSV Teaduste Akadeemia Toimetise VIII Koide Bioloogiline Seeria*. **1** : 3-14.
- JÄRVERKÜLG, A. 1961. Some Ostracods in the Brackish-water on the Estonian coast. *Faunistilisi Märkmeid* **I**(2) : 107-109.
- KEMPF, E. K. VON. 1967. Ostrakoden aus dem Holstein-Interglazial von Tönisberg (Niederrheingebiet). *Deutsch. Akad. Wissen. Berlin*. **9**(2) : 119-140.
- KESLING, R. V. 1951. The Morphology of Ostracod Molt Stages. *Illinois Bio. Monog.* **21**(1-3) : 1-324.

- KLIE, W. 1927. Zur Kenntnis der Mikrofauna von British Indien. I Ostracoda. *Rec. Indian Mus.* **29**(2) : 157-165.
- KLIE, W. 1931. Campagne speologique de C. Bolivar et R. Jeannel dans l'Amerique du Nord (1928). 3. Crustaces Ostracoes. *Arch. Zool. exp. gen.* **71** : 333-344.
- KLIE, W. 1933a. Die Ostracoden der Deutschen Limnologischen Sunda Expedition. *Arch. Hydrob. Suppl.* **11** : 447-502.
- KLIE, W. 1933b. Die Ostracodener Rift Tal Seen in Kenia (Reports on the Percy Sladen Expedition to some Rift Valley Lakes in Kenya, in 1929). *Int. Rev. ges. Hydrob. Hydrogr.* **29** : 1-14.
- KLIE, W. 1937. Zur Kenntnis der Ostracoden—Arten *Eucypris reptans* (Kaufmann) und *Loxococoncha pusilla* Brady and Robertson. *Zool. Anz.* **118** : 44-51.
- KLIE, W. 1933a. Ostracoden aus Unterirdischen Gewässern in Südtalien. *Zool. Anz.*, **123** : 148-155.
- KLIE, W. 1938b. Ostracoda. Die Tierwelt Deutschlands, Jena, Fischer.
- KLIE, W. 1939. Ostracoden aus dem Kenia—Cabinet vornehmlich von dessen Hochgebirgen. *Int. Rev. ges. Hydrob. Hydrogr.* **39** : 99-161.
- KOCH, C. L. 1838. Deutschlands Crustaceen, Myriapoden und Arachniden. In Panzer G.W.F., Ed., Fauna Insectorum Germanicae. *F. Pustet, Regensburg*, pt. **21** : 12-24.
- KRUIJF, C. 1955. Sediments of the Rhone delta. Grain size and microfauna. *Verh. KO Nederl. Geol. Mijnb. Genootsch.* **15**(3) : 357-514.
- LOWMEDES, A. G. 1931. Some Freshwater Entomostraca of the Birmingham District. *Ann. Mag. Nat. Hist.* ser. 10, **8** : 561-577.
- MALCOLMSON, J. G. 1840. On the fossils of the eastern portion of the great basaltic district of India. *Trans. Geol. Soc. London.* ser. 2, **5**(3) : 537-575.
- MARGALEF, R. 1947. Datos Zoogeograficos sobre Ostracodos de agua dulce de Cataluna y description de la nueva especie *Potamocypris pyrenaica*. *Publ. Ist. Biol. Aplicada.* **3** : 163-171.
- MARINOV, T. 1964. Untersuchungen über die Ostracoden fauna des Schwarzen Meeres. *Kieler Meeresforschungen.* **10**(1) : 82-91.
- MCKENZIE, K. G. 1964. An Ostracode Fauna from Lago di Fusaro, near Napoli. *Annuario Dell'istituto e Museo di Zoologia Della Università di Napoli.* **16**(6) : 1-23.
- MOORE, R. C. Ed. 1961. *Treatise on invertebrate paleontology, Part Q. Arthropoda 3. Ostracoda.* Geol. Soc. America, New York.
- MORONI, A. 1967. *Ostracodi delle risaie italiane.* Societa Cooperativa, Editrice Libraria, a.r. 1. PARMA.
- MUELLER, G. W. 1900. Deutschlands Süswasser—Ostracoden. *Zoologica.* pp. 1-112.
- MUELLER, O. F. 1776. *Zoologiae Danicae prodromus seu animalium Daniae et Norvegiae in digenarum.* Characters, nomina, et synonyma imprimis popularium. *Hallager.* 1-282.
- MUELLER, O. F. 1785. *Entomostraca seu Insecta Testacea, quae In aquis Daniae et Norvegiae reperit, descripsit et iconibus illustravit.* F. W. Thiele, Leipzig and Copenhagen.
- PETKOVSKI, T. K. 1958. Süswasser Ostracoden aus Jugoslawien. II subfam. Hyocyprinae. *Fragm. Balc.* **2**(8/42) : 53-57.
- PETKOVSKI, T. K. 1961. Zur Kenntnis der crustacean des Skadar (scutari) Sees. *Acta. Mus. Maced. Sci. Nat.* **8**(2)/70) : 30-52.
- PETKOVSKI, T. K. 1964. Bemerkenswerte entomostraken aus Jugoslawien. *Acta. Mus. Maced. Sci. Nat.* **9**(7/83) : 147-181.
- PURASJOKI, K. J. 1948. *Cyprilla humilis* G. O. Sars, an interesting Ostracod discovery from Finland. *Soc. Sci. Fenn. Comm. Biol.* **10**(3) : 1-7.
- RAMDOHR, F. A. 1808. über die Gattung *Cypris* Mueller und drei zu derselben gehoerige neue arten. *Mag. Gessel. Naturf. Freunde.* **2**(12) : 83-93.
- ROY, D. K. 1971. *Stratigraphy and Palaeontology of the Karewas of Kashmir.* Seminar on Recent Geology studies in the Himalayas—Oct. 29-31, 1971. Geol. Surv. India. (Abstracts) 12-13.
- SARS, G. O. 1863. Beretning om en i Sommern 1962 foretagen zoologisk Reise i Christianias og Trondhjems slifter. *Nyt. Mag. Natury.* **12** : 218-233.
- SARS, G. O. 1890. Oversigt af Norges Crustaceer med forelbige Bemaerkninger over de nye eller mindre bekjendte Arter. *Forhandl. Vidensk. Selskab. Christiania.* **1** : 15-76.
- SARS, G. O. 1924. The Freshwater Entomostraca of the Cape Province (Union of South Africa). II Ostracoda. *Ann. South African Mus.* **28**(2) : 105-191.
- SARS, G. O. 1925. *An account of the Crustacea of Norway.* Bergen Museum, Norway.
- SHOTTON, F. W. and OSBORNE, P. J. 1965. The Fauna of the Hoxnian interglacial deposits of Nechells, Birmingham with an appendix on *Cytherissa lacustris* and other ostracodes at Nechells by P. C. Sylvester-Bradley. *Philos. Trans. Roy. Soc. London.* ser. B, **248** : 353-378.
- SINGH, D. 1969. Some additional Ostracodes from the Upper and Lower Karewas, Kashmir. *Bull. Indian Geol. Assoc.* **2**(3-4) : 121.
- SINGH, D. 1970. Some Ostracodes from the Karewas (Pleistocene) of Kashmir. *Proc. Indian Sci. Congr.* (Abstracts) pt. **3** : 202.
- SINGH, D. 1971a. Ostracode fauna from Pleistocene of Kashmir Valley. *Proc. Indian Sci. Congr.* (Abstracts). pt. **3** : 319-320.
- SINGH, D. 1971b. *The Quaternary and Recent Ostracode fauna from Kashmir.* Unpublished Ph. D. Thesis, Panjab Univ., Chandigarh.
- SINGH, D. 1972. The Ostracode fauna from the Plio-Pleistocene (Karewas) and Recent of Kashmir. *Curr. Sci.* **41**(22) : 817-818.
- SINGH, D. 1973a. A note on the Age of the Karewa. *Proc. Indian Sci. Congr.* (Abstracts). pt. **3** : 191.
- SINGH, D. 1973b. Plio-Pleistocene and Recent Ostracode Taxa from the Kashmir valley and their affinity. *Proc. Indian Sci. Congr.* (Abstracts). pt. **3** : 199.
- SINGH, D. 1973c. A note on palaeoecology of the Karewa. *Proc. Indian Sci. Congr.* (Abstracts). pt. **3** : 199-200.
- SINGH, D. 1973d. Ecology, palaeoecology and palaeozoogeography of Quaternary ostracodes of Kashmir, India. *Bull. Indian Geol. Assoc.* **6**(2) : 157-176.
- SINGH, D. 1974a. Some observations on Biostratigraphy of the Karewa Series. *Proc. Indian Sci. Congr.* (Abstracts). pt. **3** : 139-140.
- SINGH, D. 1974b. Some new fresh-water Quaternary ostracodes from Kashmir, India. *Bull. Indian Geol. Assoc.* **7**(2) : 99-122.
- SINGH, D. 1974c. *Taxonomic and Morphologic Comments on certain Ostracode taxa from Kashmir, India* IV Colloquium on Indian Micro-palaeontology and stratigraphy, 1974, Institute of Petroleum Exploration (O.N.G.C.), Dehradun. (Abstracts) 41.
- STAPLIN, F. L. 1963a. Pleistocene Ostracoda of Illinois. Part I. Subfamilies Candoniae, Cyprinae, general ecology, morphology. *Jour. Paleont.* **37**(4) : 758-787.
- STAPLIN, F. L. 1963b. Pleistocene Ostracoda of Illinois. Part II. Subfamilies Cycloocyprinae, Cypridopsinae, Hyocyprinae; Families Darwinulidae and Cythridae. Stratigraphic ranges and assemblage patterns. *Jour. Paleont.* **37**(6) : 1164-1203.
- STEPHANIDES, T. 1948. A survey of the Freshwater biology of Corfu and of certain other regions of Greece. *Prakt. Hellen. Hydrobiol. Inst. Acad. Athens.* **11**(2) : 1-263.
- STEPHANIDES, T. 1960. A seasonal survey of the Entomostraca in three Corfu ponds. *Prakt. Hellen. Hydrobiol. Inst. Acad. Athens.* **7**(4) : 5-20.
- STRAUB, E. W. 1952. Mikropalaeontologische Untersuchungen im Tertiär Zwischen Ethingen und Ulma a. d. Donau. *Geol. Jahrb.* **66** : 433-524.
- SYLVESTER-BRADLEY, P. C. 1941. The shell structure of the Ostracoda and its application to their paleontological investigation. *Ann. Mag. Nat. Hist.* ser. **11** : 1-33.

- TRESSLER, W. L. 1937. Ostracoda. *Int. Rev. ges. Hydrob. Hydrogr.* **34** : 188-207.
- TRESSLER, W. L. 1957. The Ostracoda of Great Slave Lake. *Jour. Washington Acad. Sci.* **47**(12) : 415-423.
- TRIEBEL, E. 1953. Genotypus und Schalenmerkmale der Ostracoden Gattung *Stenocypris*. *Senckenbergiana Lethaea*. **34**(1)3 : 5-14.
- TRIEBEL, E. 1963. Ostracoden Aus Dem Sannois und Jüngerem Schichten Des Mainzer Beckens. I. Cyprididae. *Senckenbergiana Lethaea*. **44**(3) : 157-207.
- TURNER, C. H. 1895. *Freshwater Ostracoda of the United States*. Second Report of the State Zoologist, Zoological Series, II, Saint Paul, Minnesota. 279-337.
- VAVRA, W. 1891. Monographic der Ostracoden Böhmens. *Arch. naturwiss. Landesdurchforsch. Böhmen*. **3** : 1-116.
- WAGNER, C. W. 1957. *Sur les ostracodes du Quaternaire récent des Pays-Bas et leur utilisation dans l'étude géologique des dépôts Holocènes*. Mouton and Co., The Hague.
- WINKLER, E. M. 1962. Two late Pleistocene (Cary) freshwater Ostracode faunas. *Journ. Paleont.* **36**(5) : 1021-1034.

EXPLANATION TO PLATES 1-12

PLATE I

(All figures $\times 60$)

- 1—11 *Cypris pubera* Mueller. 1—adult R.V., int. view ; 2—juvenile R.V., ext. view ; 3—juvenile L.V., ext. view ; 4—juvenile R.V., ext. view ; 5—juvenile R.V., ext. view ; 6—juvenile L.V., ext. view ; 7—juvenile L.V., ext. view ; 8—juvenile R.V., ext. view ; 9—juvenile R.V., ext. view ; 10—juvenile L.V., ext. view ; 11—juvenile R.V., ext. view.

PLATE II

All figures $\times 60$

- 1—8 *Cypris subglobosa* Sowerby. 1—adult L.V., int. view ; 2—adult R.V., int. view ; 3—juvenile L.V., ext. view ; 4—juvenile R.V., ext. view ; 5—juvenile R.V., ext. view ; 6—juvenile L.V., ext. view ; 7—juvenile L.V., ext. view ; 8—juvenile L.V., ext. view.
- 9-12 *Dolerocypris* sp. of *D. fasciata* (Mueller). 9—adult R.V. (broken), ext. view ; 10-11—juvenile R.V., 10—ext. view, 11—int. view ; 12—juvenile R.V., ext. view.

PLATE III

(All figures $\times 60$)

- 1—3 *Eucypris* sp. cf. *E. clavata* (Baird). 1—adult R.V., int. view ; 2—juvenile R.V., int. view ; 3—juvenile, R.V., int. view

PLATE IV

(All figures $\times 60$)

- 1—5 *Eucypris* sp. cf. *E. clavata* (Baird). 1—juvenile R.V., int. view ; 2—juvenile R.V., int. view ; 3—juvenile R.V., int. view ; 4—juvenile, R.V., int. view ; 5—juvenile R.V., int. view.
- 6 *Eucypris* sp. cf. *E. moguntiensis* Triebel —adult L.V., int. view.
- 7—14 *Eucypris zenkeri* (Chyzer and Toth). 7—adult L.V., int. view ; 8—juvenile R.V., int. view ; 9—juvenile L.V., int. view ; 10—juvenile L.V., int. view ; 11—juvenile R.V., int. view ; 12—juvenile, L.V., int. view ; 13—juvenile L.V., int. view ; 14—juvenile L.V., int. view.

PLATE V

(All figures $\times 60$)

- 1—4 *Herpetocypris reptans* (Baird). 1—adult L.V., int. view ; 2—juvenile R.V., int. view ; 3—juvenile R.V., int. view ; 4—juvenile L.V., int. view.

PLATE VI

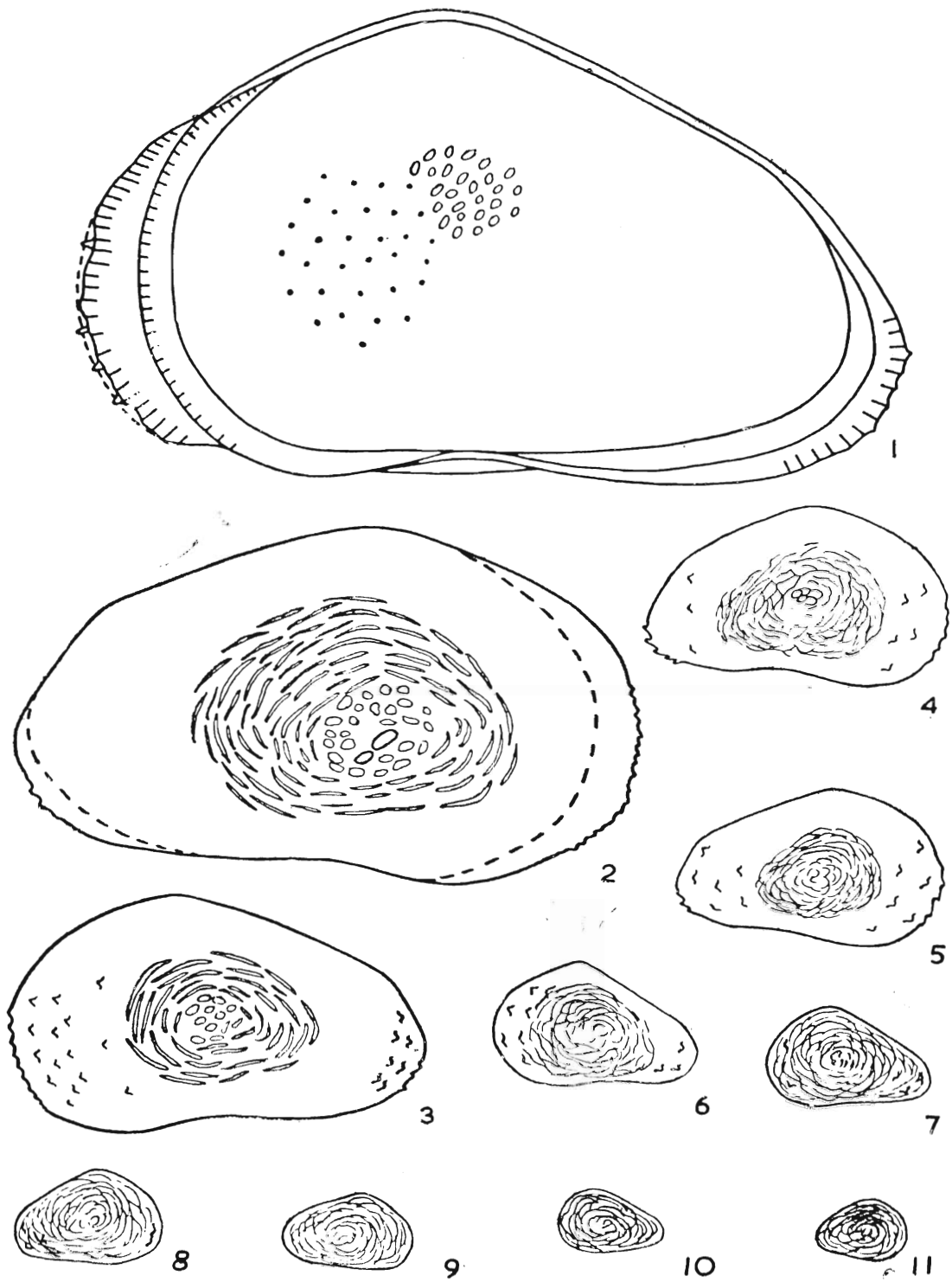
(All figures $\times 60$)

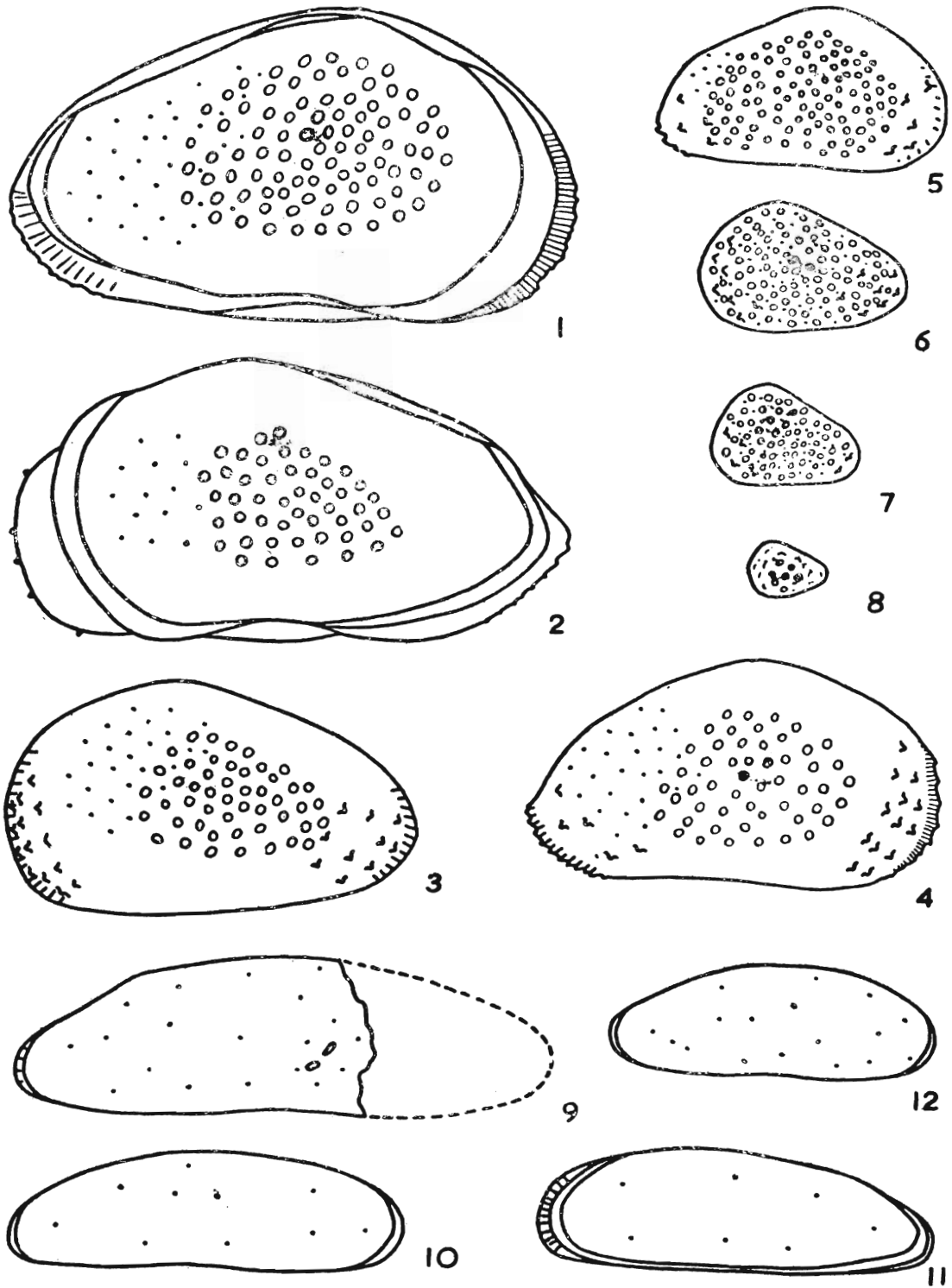
- 1—4 *Herpetocypris reptans* (Baird). 1—juvenile R.V., int. view ; 2—juvenile L.V., int. view ; 3—juvenile R.V., int. view ; 4—juvenile L.V., int. view.
- 5—13 *Heterocypris incongruens* (Ramdohr). 5—adult L.V., int. view ; 6—adult R.V., int. view ; 7—juvenile R.V., ext. view ; 8—juvenile R.V., ext. view ; 9—juvenile R.V., ext. view ; 10—juvenile L.V., ext. view ; 11—juvenile R.V., ext. view ; 12—juvenile R.V., ext. view ; 13—juvenile R.V., ext. view.

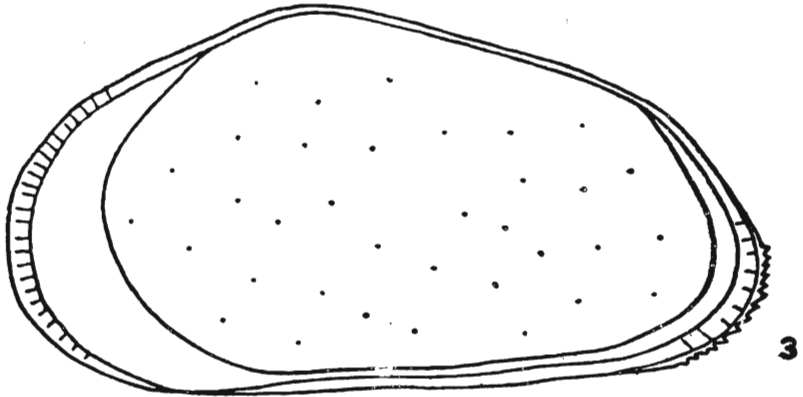
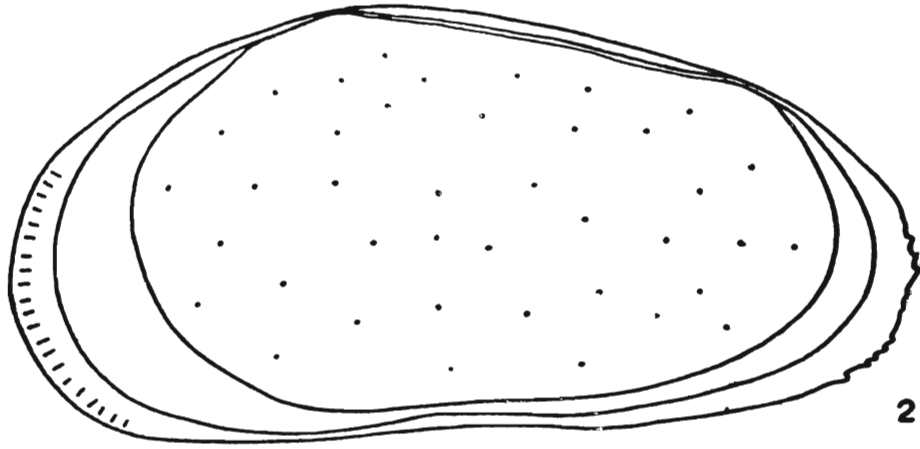
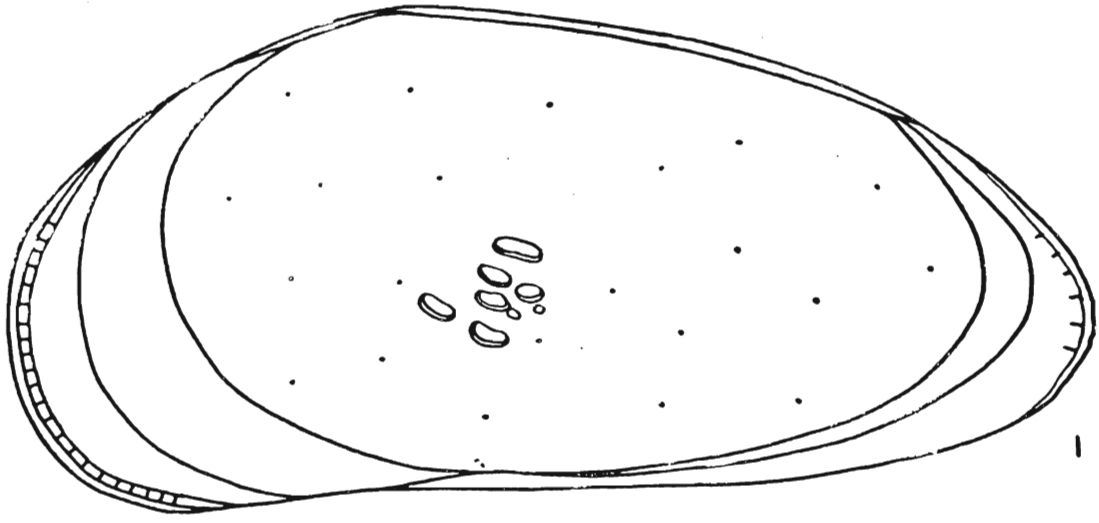
PLATE VII

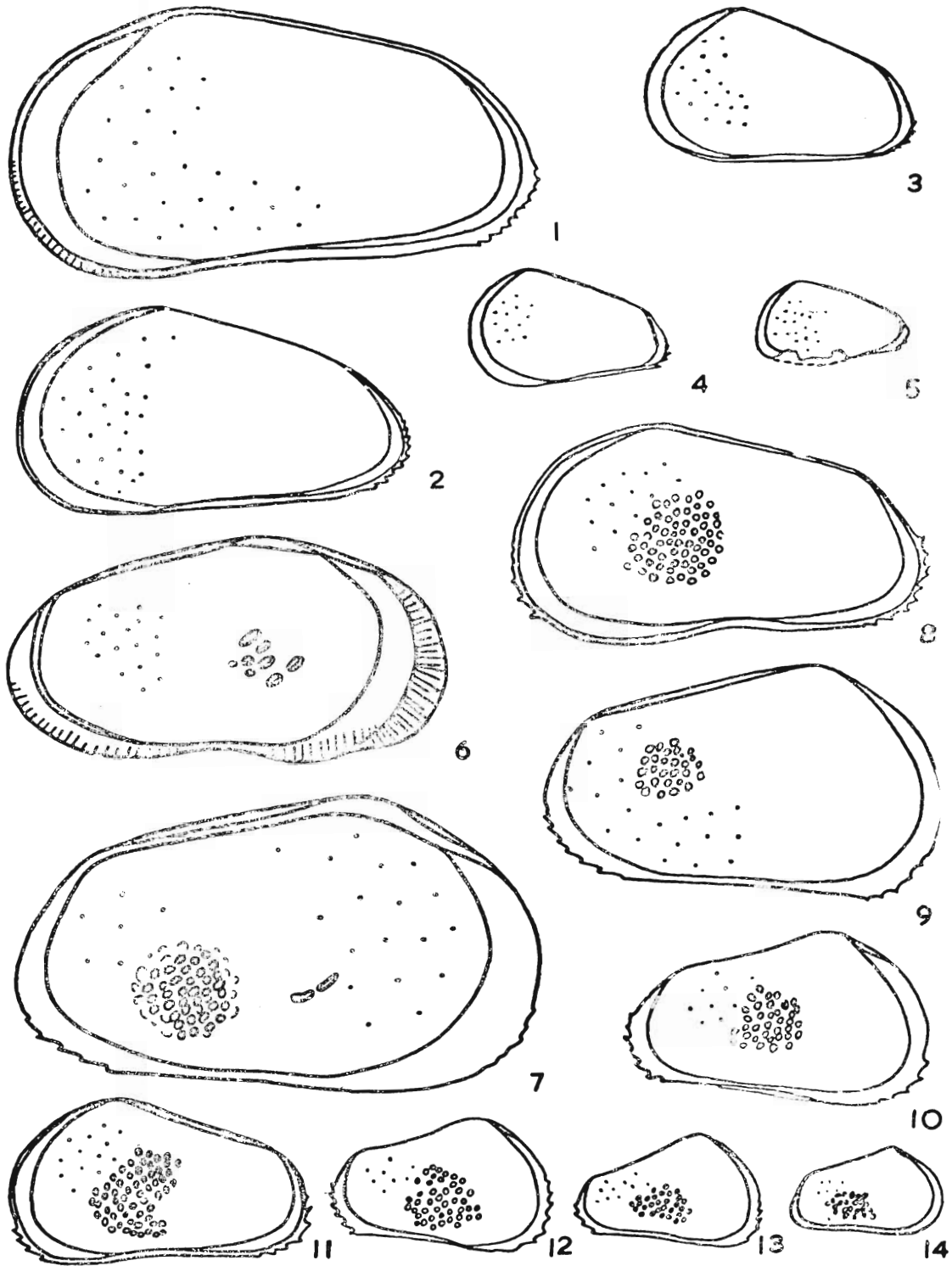
All figures $\times 60$

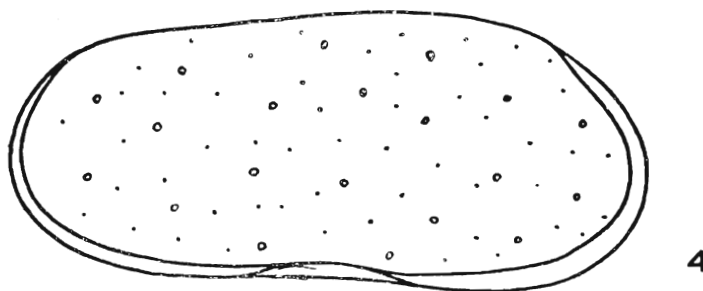
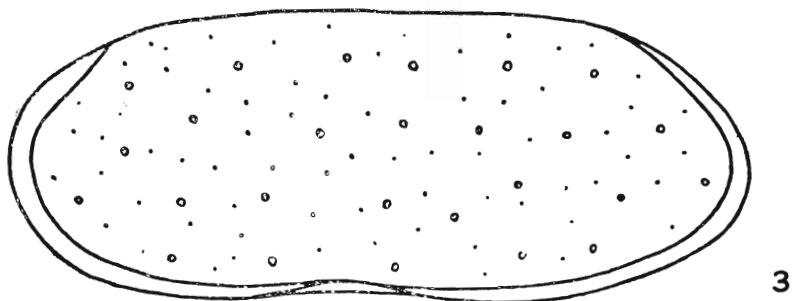
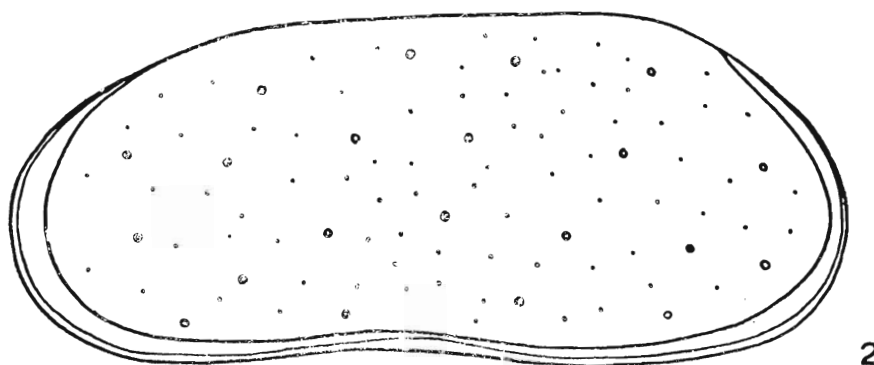
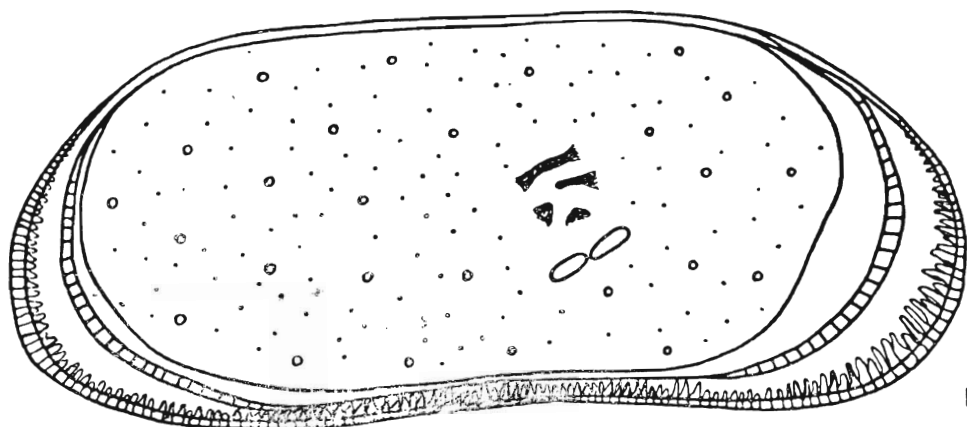
- 1—5 *Isocypris priomena* Mueller. 1—juvenile L.V., int. view ; 2—juvenile R.V., int. view ; 3—juvenile L.V., int. view ; 4—juvenile R.V., int. view ; 5—juvenile L.V., int. view.
- 6—9 *Stenocypris major* (Baird). 6—juvenile L.V., int. view ; 7—juvenile L.V., int. view ; 8—juvenile R.V., int. view ; 9—juvenile R.V., int. view.
- 10 *Zonocypris costata* (Vavra). adult R.V., ext. view.
- 11—16 *Cypridopsis aculeata* (Lilljeborg). 11—adult L.V., int. view ; 12—adult R.V., int. view ; 13—juvenile L.V., int. view ; 14—juvenile R.V., int. view ; 15—juvenile L.V., int. view ; 16—juvenile R.V., int. view.

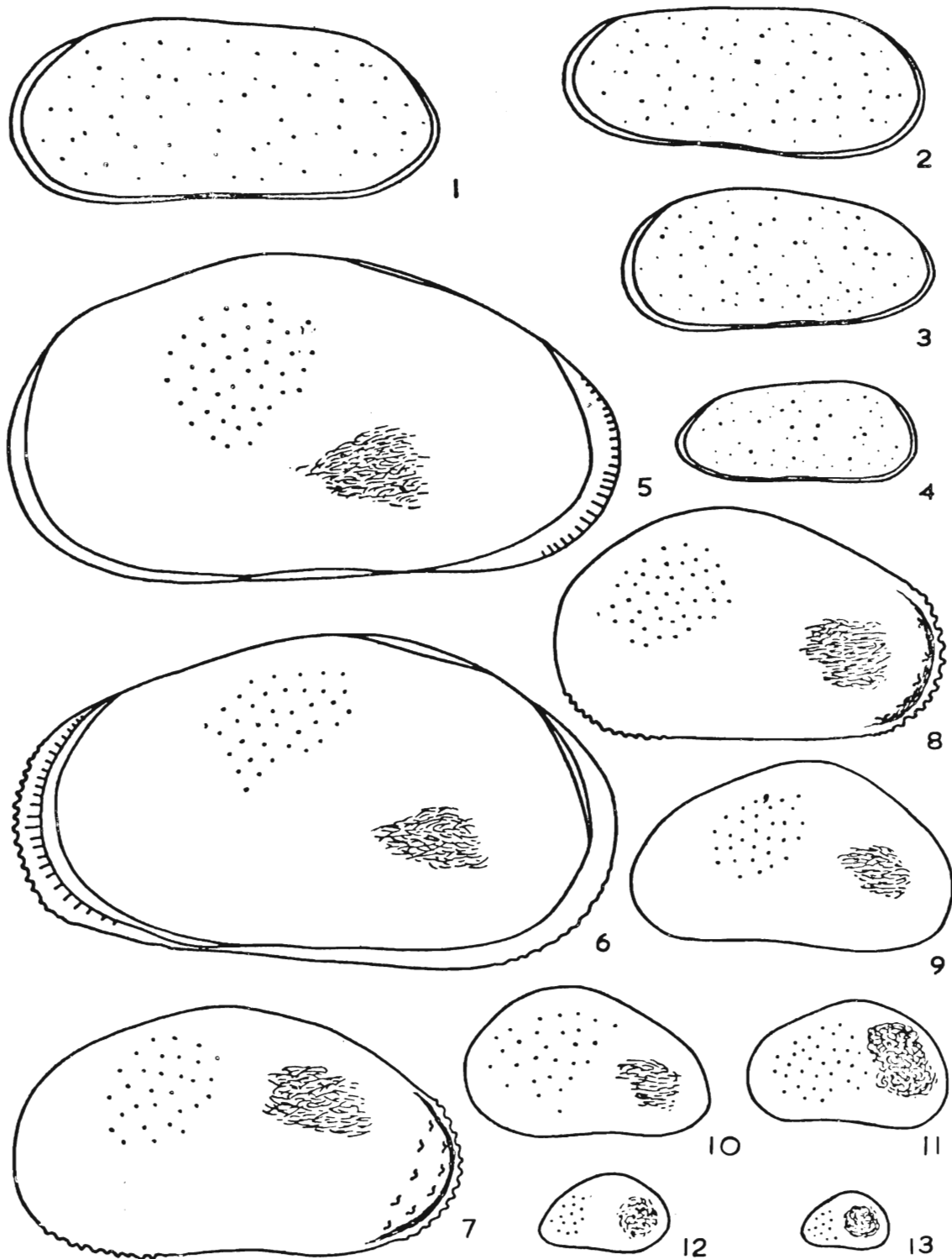


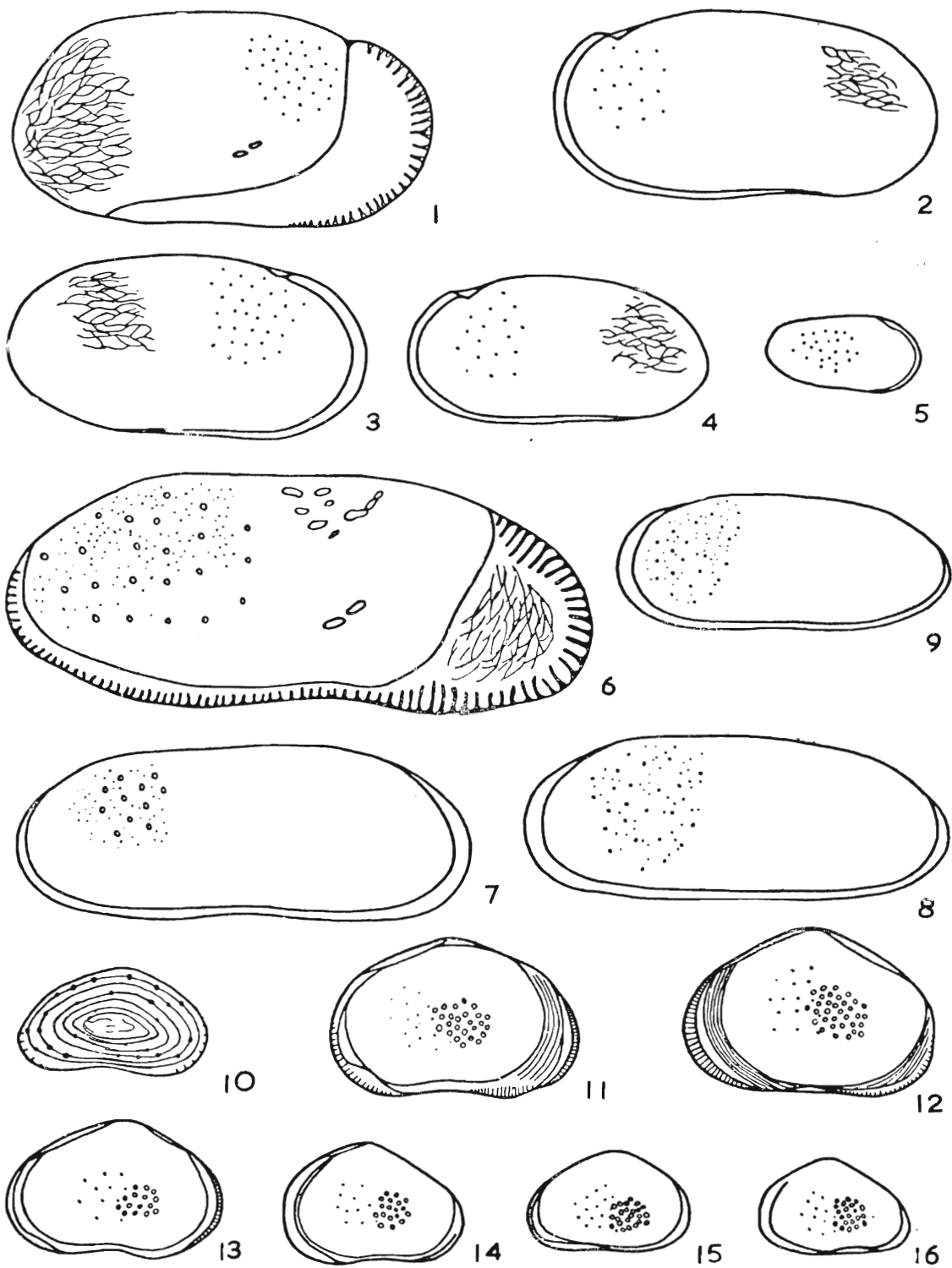


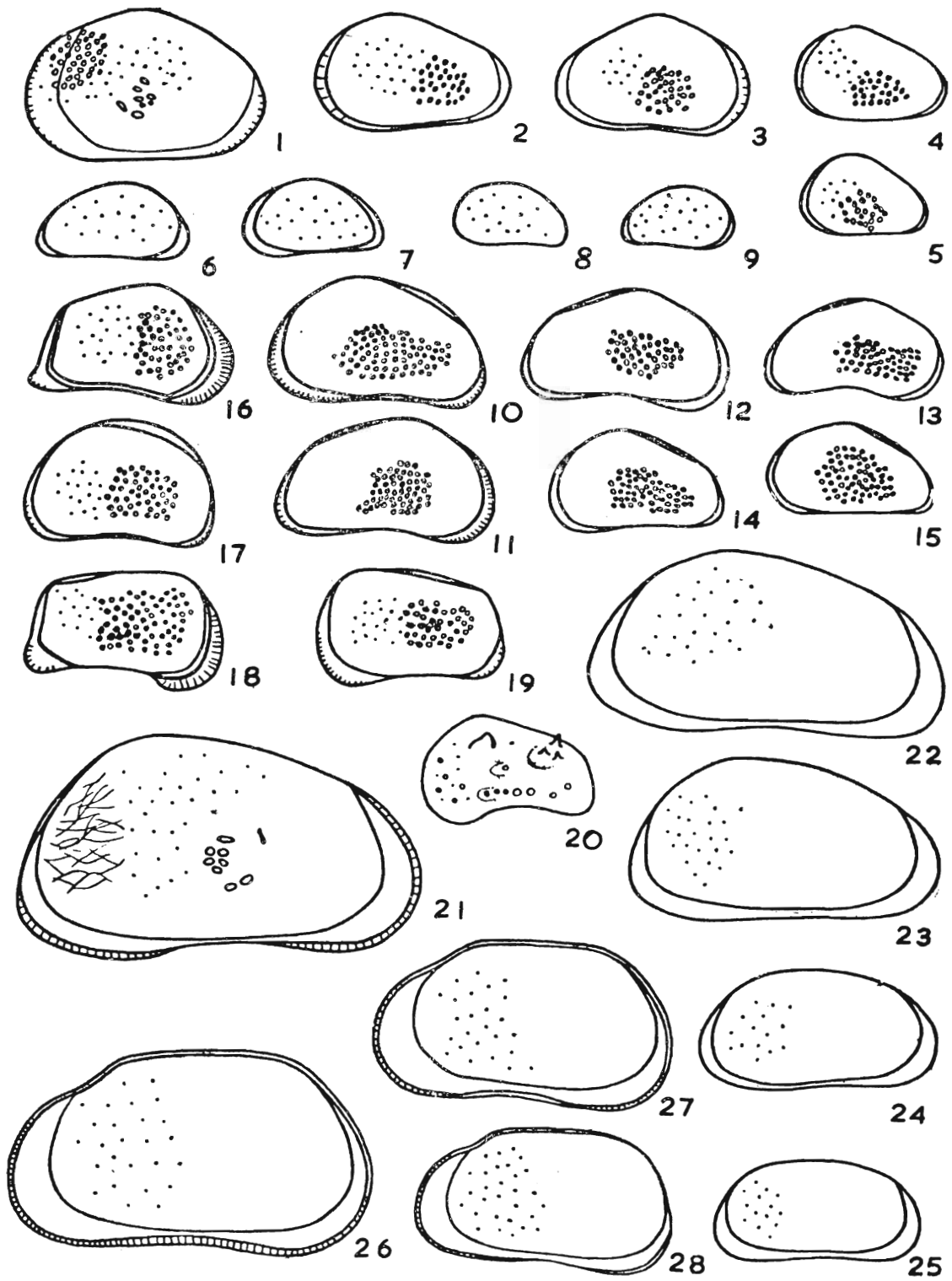


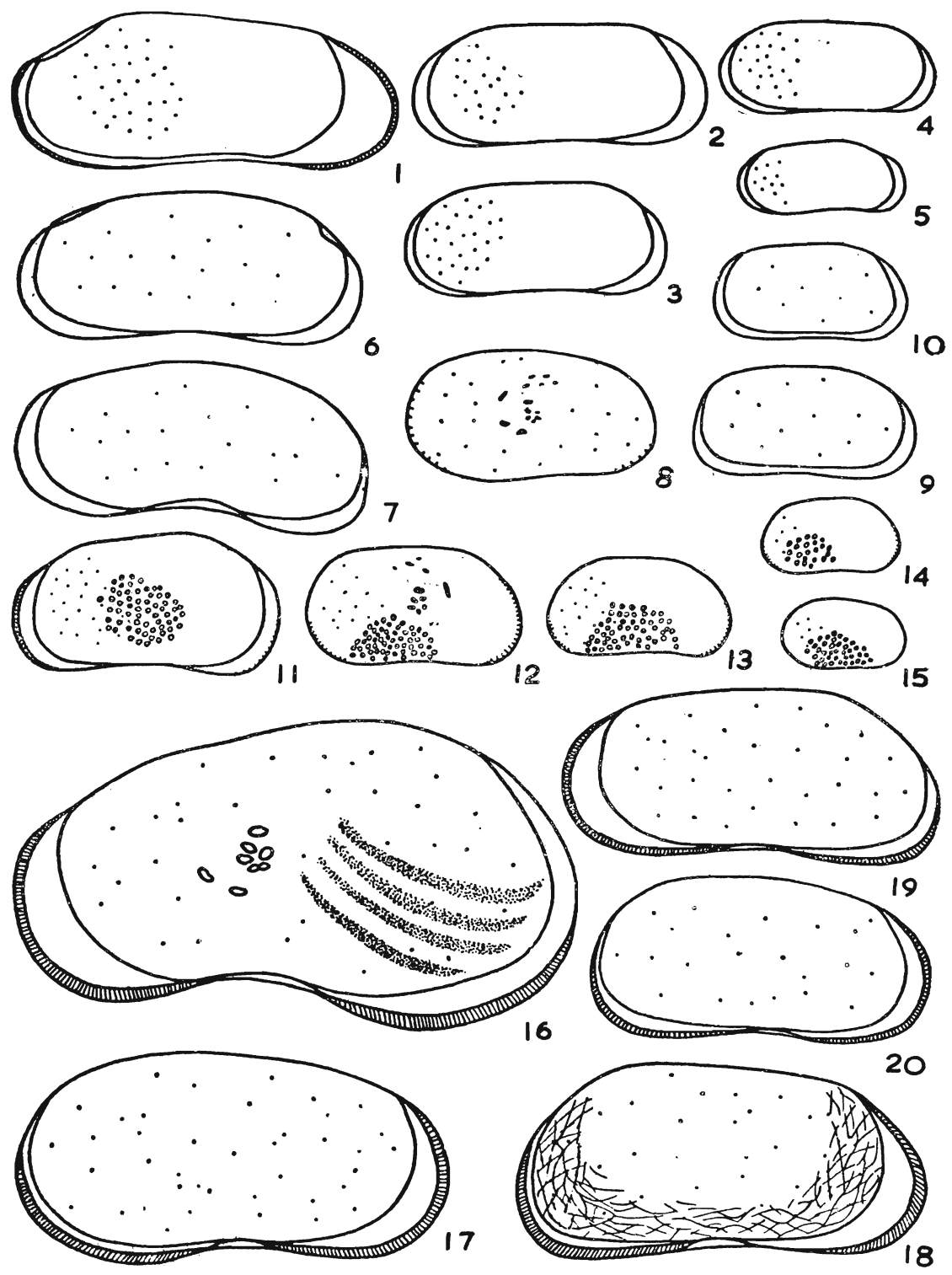


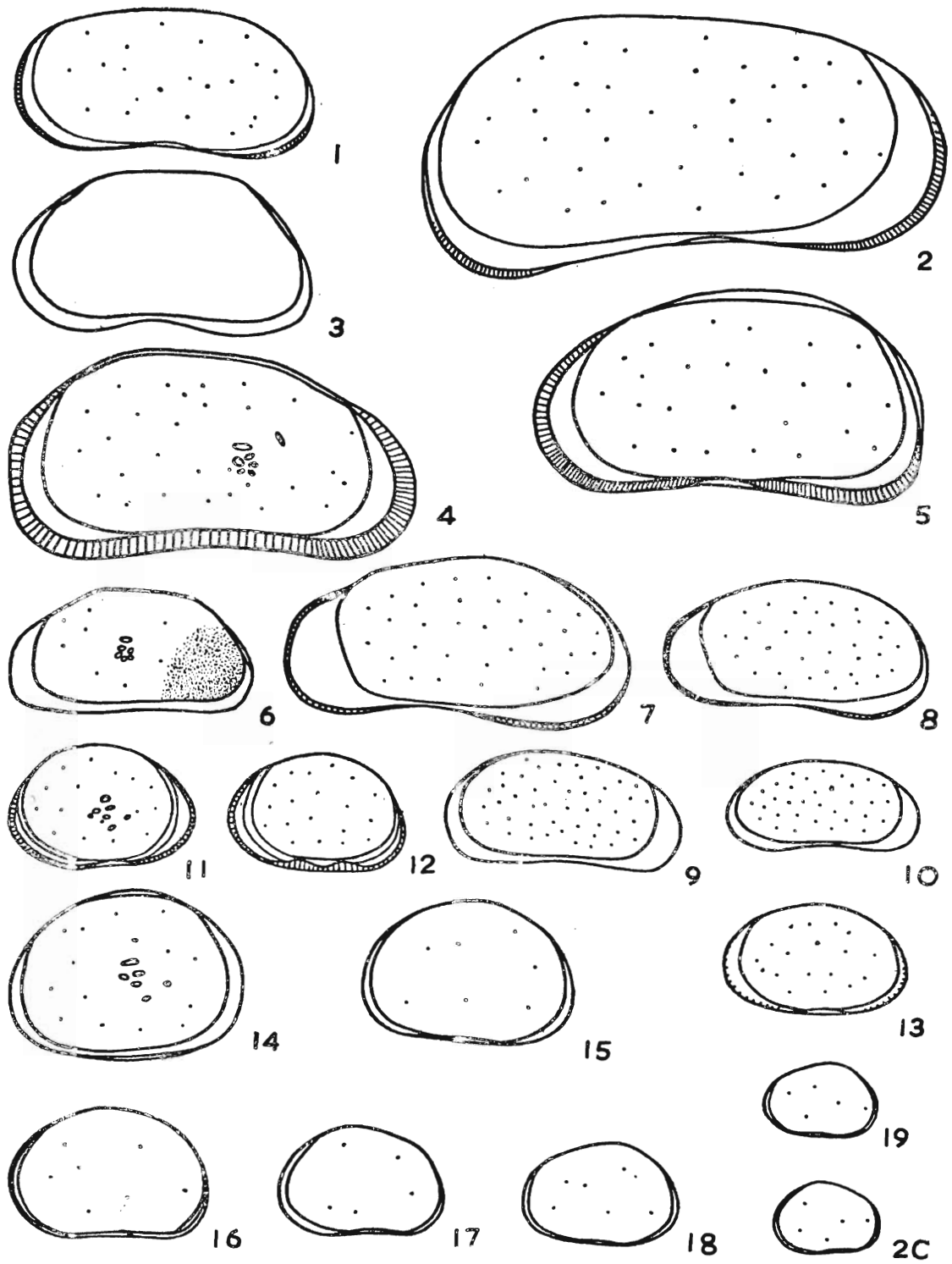


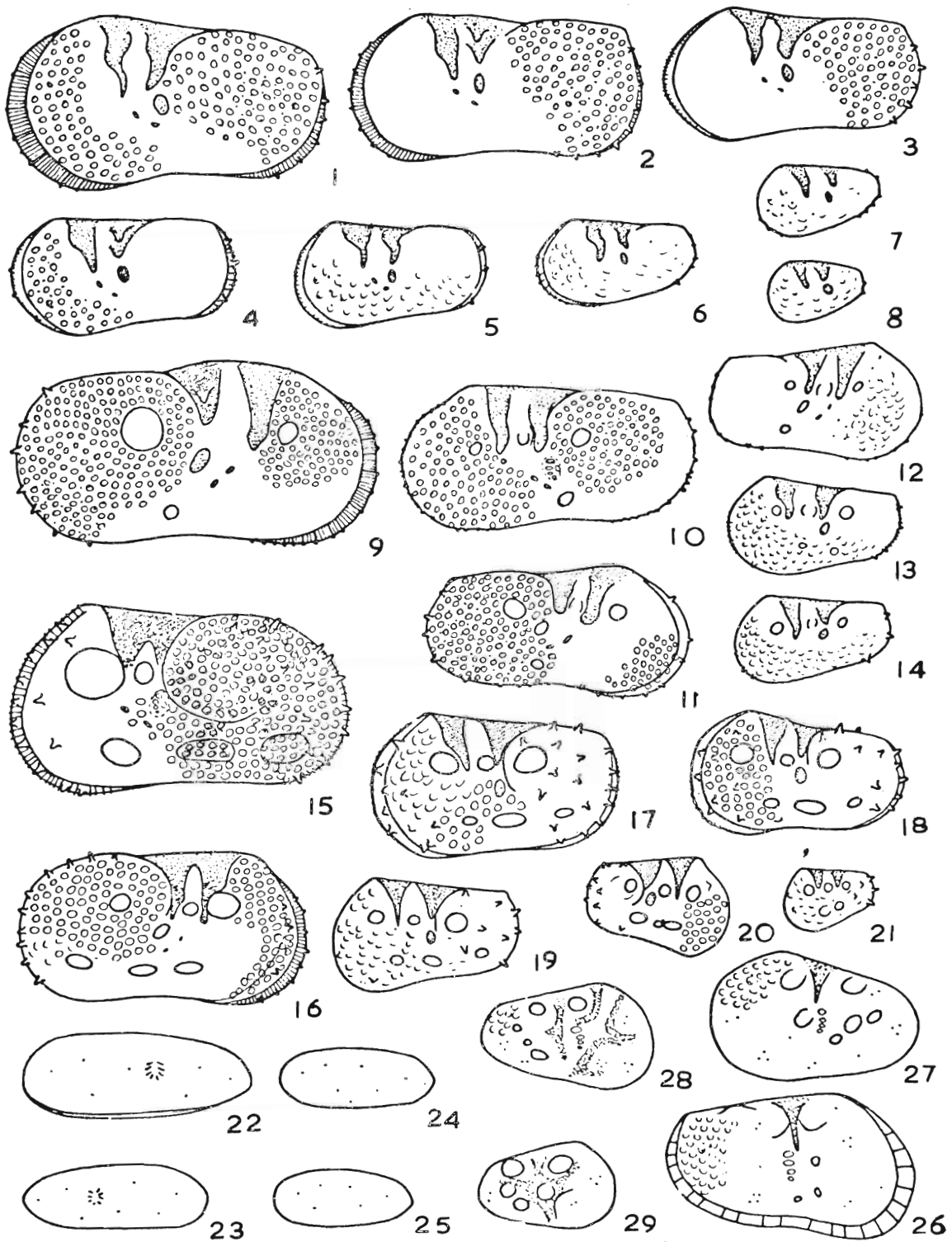












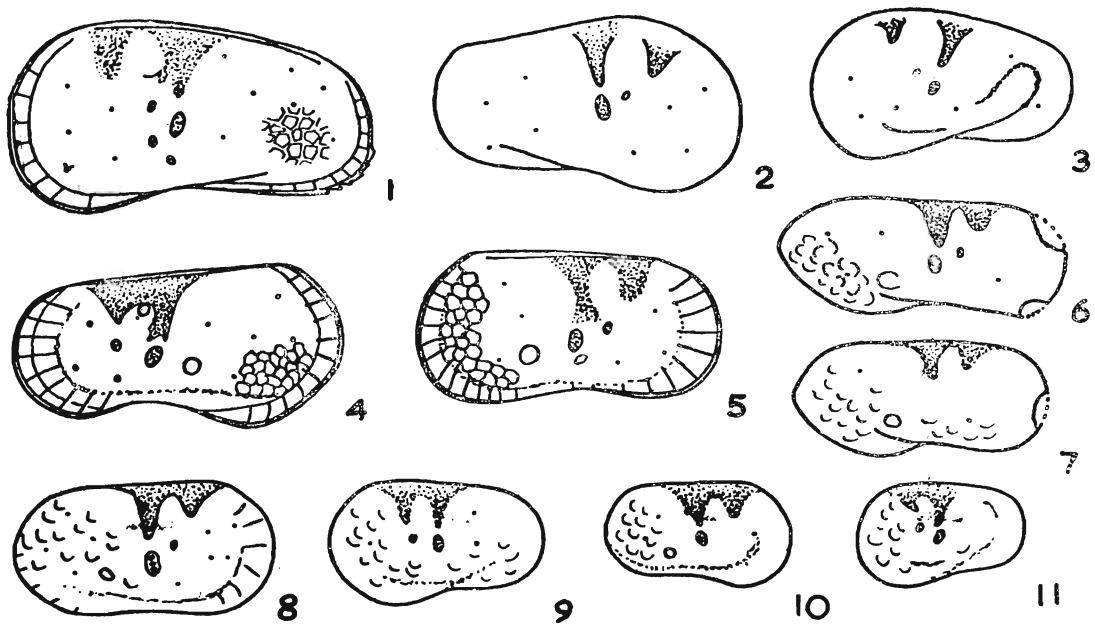


PLATE VIII
(All figures $\times 60$)

- 1—5 *Cypridopsis vidua* (Mueller). 1—adult L.V., ext. view; 2—juvenile L.V., ext. view; 3—juvenile R.V., ext. view; 4—juvenile L.V., ext. view; 5—juvenile L.V., ext. view.
 6—9 *Potamocypris minuta patriciae* Bhatia. 6—adult L.V., int. view; 7—adult R.V., int. view; 8—juvenile L.V., ext. view; 9—juvenile R.V., ext. view.
 10—15 *Potamocypris smaragdina* (Vavra). 10—adult R.V., int. view; 11—adult L.V., int. view; 12—juvenile L.V., int. view; 13—juvenile L.V., int. view; 14—juvenile R.V., int. view; 15—juvenile R.V., int. view.
 16—17 *Potamocypris (Cyprilla) arcuata* (Sars). 16—adult L.V., int. view; 17—adult R.V., int. view.
 18—20 *Potamocypris (Cyprilla) humilis* (Sars). 18—adult L.V., int. view; 19—adult R.V., int. view; 20—juvenile L.V., ext. view.
 21—25 *Candona candida* (Mueller). 21—adult L.V., int. view; 22—juvenile L.V., int. view; 23—juvenile L.V., int. view; 24—juvenile L.V., int. view; 25—juvenile L.V., int. view.
 26—28 *Candona compressa* (Koch). 26—adult R.V., int. view; 27—juvenile R.V., int. view; 28—juvenile R.V., int. view.

PLATE IX
(All figures $\times 60$)

- 1—5 *Candona fabaeformis* (Fischer). 1—adult L.V., int. view; 2—juvenile L.V., int. view; 3—juvenile L.V., int. view; 4—juvenile L.V., int. view; 5—juvenile L.V., int. view.
 6—7 *Candona* sp. of *C. havanaensis* Staplin. 6—adult L.V., int. view; 7—adult R.V., int. view.
 8—10 *Candona lactea* Baird. 8—adult L.V., ext. view; 9—juvenile L.V., int. view; 10—juvenile L.V., int. view.
 11—15 *Candona marengoensis* Klie. 11—adult R.V., int. view; 12—juvenile R.V., ext. view; 13—juvenile R.V., ext. view; 14—juvenile R.V., ext. view; 15—juvenile L.V., ext. view.
 16—20 *Candona neglecta* Sars. 16—adult male R.V., int. view; 17—juvenile male L.V., int. view; 18—juvenile female L.V., int. view; 19—juvenile female R.V., int. view; 20—juvenile L.V., int. view.

PLATE X
(All figures $\times 60$)

- 1—2 *Candona neglecta* Sars. 1—juvenile R.V., int. view; 2—adult female L.V., int. view.
 3 *Candona* sp. cf. *C. pearlensis* Staplin. adult R.V., int. view.
 4—5 *Candona rawsoni* Tressler. 4—adult L.V., int. view; 5—adult R.V., int. view.
 6 *Candona* sp. cf. *C. Stammeri* Klie. adult R.V., int. view.
 7—10 *Candonopsis kingsleii* (Brady and Robertson). 7—adult R.V., int. view; 8—juvenile R.V., int. view; 9—juvenile L.V., int. view; 10—juvenile L.V., int. view.
 11—12 *Cyclocypris laevis* (Mueller) 11—adult L.V., int. view; 12—adult R.V., int. view.
 13 *Cyclocypris ovum* (Jurine). adult R.V., int. view.
 14—20 *Cypria ophthalmica* (Jurine) 14—adult L.V., int. view; 15—juvenile L.V., int. view; 16—juvenile R.V., int. view; 17—juvenile R.V., int. view; 18—juvenile L.V., int. view; 19—juvenile L.V., int. view; 20—juvenile R.V., int. view.

PLATE XI
(All figures $\times 60$)

- 1—3 *Ilyocypris bradyi* Sars. 1—adult L.V., ext. view; 2—juvenile L.V., ext. view; 3—juvenile L.V., ext. view; 4—juvenile L.V., ext. view; 5—juvenile L.V., ext. view; 6—juvenile L.V., ext. view; 7—juvenile L.V., ext. view; 8—juvenile L.V., ext. view.
 9—14 *Ilyocypris gibba* (Ramdohr). 9—adult R.V., ext. view; 10—juvenile L.V., ext. view; 11—juvenile R.V., ext. view; 12—juvenile R.V., ext. view; 13—juvenile L.V., ext. view; 14—juvenile L.V., ext. view;
 15—21 *Ilyocypris shauneeetownensis* Staplin. 15—adult L.V., ext. view; 16—juvenile R.V., ext. view; 17—juvenile L.V., ext. view; 18—juvenile L.V., ext. view; 19—juvenile L.V., ext. view; 20—juvenile R.V., ext. view; 21—juvenile L.V., ext. view.
 22—25 *Darwinula stevensoni* (Brady and Robertson). 22—adult L.V., int. view; 23—juvenile L.V., ext. view; 24—juvenile R.V., ext. view; 25—juvenile R.V., ext. view.
 26—29 *Cytherissa lacustris* (Sars). 26—juvenile R.V., ext. view; 27—juvenile L.V., ext. view; 28—juvenile R.V., ext. view; 29—juvenile R.V., ext. view.

PLATE XII
(All figures $\times 60$)

- 1—3 *Limnocythere blankenbergensis* Diebel. 1—adult L.V., ext. view; 2—juvenile R.V., ext. view; 3—juvenile L.V., ext. view.
 4—11 *Limnocythere franki* Bhatia. 4—adult male L.V., ext. view; 5—adult female R.V., ext. view; 6—juvenile male R.V., ext. view; 7—juvenile male R.V., ext. view; 8—juvenile female R.V., ext. view; 9—juvenile female L.V., ext. view; 10—juvenile R.V., ext. view; 11—juvenile L.V., ext. view.