

**ABSTRACT:** The suborder Cladocopa comprises three genera and about forty-one living species, which are worldwide in distribution. Most Recent species are limited to the coastal waters of northwestern Europe and the Mediterranean Sea. Fossil occurrences are limited to Europe, with the exception of four specimens found near the top of a North Atlantic sediment core. Large forms from the Paleozoic of Europe are referable to the family Leperditellidae rather than to the Cladocopa. Recent Cladocopa are found exclusively in waters of normal salinity, and seem to prefer water temperatures between 4° and 14° C. Although collected occasionally at depths of 1280 to 2600 meters, they are usually found in waters less than 500 meters deep. The geologic evidence indicates that the anterior shell concavity was a late acquisition and may be an adaptation permitting more efficient swimming. If so, this may enable the Cladocopa to compete more successfully, and thus may account for the relatively large number of species of Cladocopa existing at the present time. A new species of the genus *Polycope* from the Great Bahama Bank is described and figured. Important papers concerning Recent Cladocopa are included in the bibliography.

## Distribution of the ostracode suborder Cladocopa, and a new species from the Bahamas

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### INTRODUCTION

The suborder Cladocopa was proposed in 1866 by G. O. Sars to include the genus *Polycope*, which is the type of the family Polycopidae, the only family in this suborder. In the year 1894 G. W. Müller added another genus, *Polycopsis*, to the family, and suppressed the suborder Cladocopa by placing the family Polycopidae under the suborder Myodocopa. Skogsberg (1920, p. 158) concurred with Sars and retained the separate suborder, but used a different name, Polycopiformes, for it. Klie, in 1936, added the genus *Parapolycope* to the same family and presented additional evidence for maintaining the suborder. The writer concurs with Sars and Klie.

Recent Cladocopa are characterized by having a small oval shell, with or without a very slight anterior concavity. The valves are generally thin and translucent and are not strongly calcified. The male is usually slightly smaller than the female. Cladocopa differ from the members of all other ostracode suborders in having biramous second antennae on which the endopodite and exopodite are similar in size and are each provided with long setae. The left lamella of the male caudal furca usually contains fewer claws than the right and also adjoins the copulatory organ.

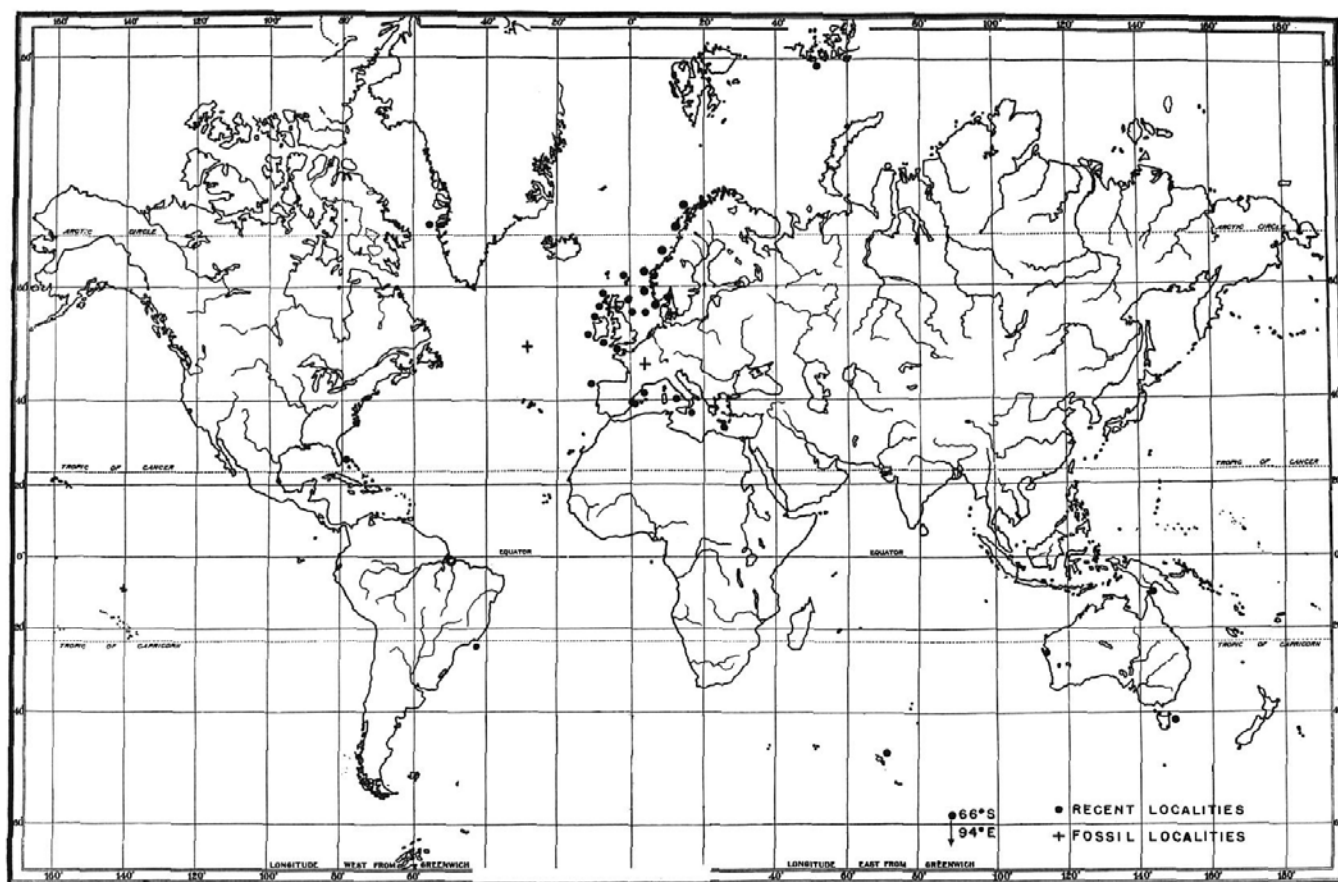
### DISTRIBUTION OF LIVING CLADOCOPA

The Cladocopa are represented in their greatest diversity and abundance in the coastal waters of Europe (text-fig. 1), but this finding may be merely a consequence of the relatively thorough studies made in this area. Representatives have also been reported from widely separated localities, such as Antarctica (G. W. Müller, 1908), Tasmania (Chapman, 1919), Torres Straits (G. S. Brady, 1880), the Kerguelen Islands (G. S. Brady, 1880), Davis Strait, Greenland (Norman, 1877), Franz-Josef Land (Scott, 1899), the Cape of Good Hope (G. S. Brady, 1880), off the coast of Brazil (Hartmann, 1954), in the northwest portion of the Gulf of Mexico (Tressler, 1954), and in mud lumps collected from the Mississippi delta (H. V. Andersen, written communication, 1958).

### DISTRIBUTION AND CLASSIFICATION OF FOSSIL CLADOCOPA

Cladocopa are known with certainty from the Recent and Pleistocene. They have also been recorded from the Cretaceous, Jurassic, Carboniferous, and Devonian. Some of these records are subject to question.

*Polycope orbicularis* G. O. Sars is the only known Pleistocene species. It is a common form living in



TEXT-FIGURE 1

## DISTRIBUTION OF THE OSTRACODE SUBORDER CLADOCOPA

the seas around northeastern Europe, and is present but less abundant elsewhere. Fossil specimens have also been collected from glacial and post-glacial beds at many localities in Scotland (Brady, Crosskey, and Robertson, 1874), and four specimens were found 0.5 meter below the top of sediment core obtained from the top of the "Faraday Hills," a narrow part of the mid-Atlantic ridge (Tressler, 1942).

Moore (1878) listed, without figures or description, a *Polycopa* sp.(?) from the Cretaceous of England. Whether this record is correct or not is a matter of uncertainty.

The species reported by Terquem (1885, 1886) from the Jurassic of France possibly belong to the Cladocopa. They lack the slight anterior sinus characteristic of most Recent species, but their size-range is consistent with the group.

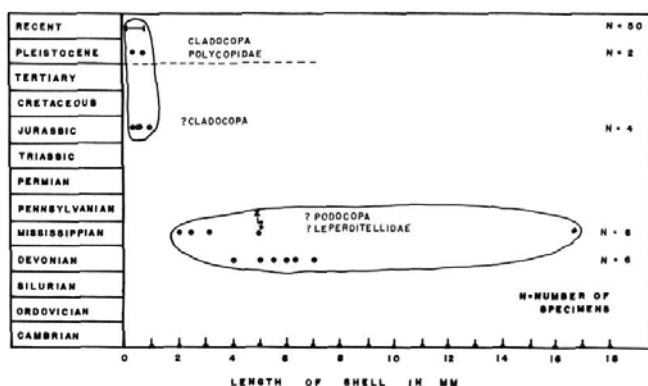
*Polycopa burrovii* Jones, Kirkby and Brady, *Polycopa simplex* (Jones and Kirkby), and *Polycopa youngiana* (Jones and Kirkby) have been recorded from the Carboniferous of the British Isles. *Polycopa devonica*

Jones, *Polycopa devonica concinna* Whidborne, *Polycopa devonica major* Whidborne, *Polycopa devonica obliqua* Whidborne, and *Polycopa hughesiae* Whidborne have been recorded from the Devonian of England. These species probably do not belong to the Cladocopa, because of their very large size (see text-fig. 2). It is the writer's opinion that these Paleozoic forms probably belong to the Paleozoic family Leperditellidae.

The species reported by Rzehak (1910) from the Devonian of Moravia (*Polycopa clymeniarum* Rzehak and *Polycopa* sp.) are too elongate to belong to the suborder Cladocopa, and for this reason their measurements have been excluded from text-figure 2. The shell lengths reported by Rzehak for these species range from 0.75 to 1.5 mm.

The only fossil species of the Cladocopa recorded from the North American continent is *Polycopa sublenticularis* Jones, collected from the Lower Silurian of Anticosti Island, Quebec. This species was transferred to the genus *Schmidtella* of the family Leperditellidae by Bassler (1915).

## DISTRIBUTION OF CLADOCOPA



TEXT-FIGURE 2

SHELL LENGTH IN FOSSIL AND RECENT CLADOCOPA

### ECOLOGY OF THE CLADOCOPA

#### Behavior

Cladocopids are rapid swimmers but evidently remain close to the bottom, and may be considered benthonic. However, on at least one occasion, *Polycope orbicularis* has been collected with plankton (Ostenfeld and Wesenberg-Lund, 1909). During swimming, the maxillae and the setae of the first and second antennae project from the shell anteriorly and move rapidly in a vertical plane. When the animal is disturbed, the appendages are withdrawn, and the shell is closed tightly (Sars, 1922).

#### Temperature

Cladocopids have been collected from near Antarctica, in water at 1.8° C. (G. W. Müller, 1908), as well as from the Bahamas, in water at 29.2° C. The group as a whole is thus markedly eurythermal. The group reaches its greatest abundance and diversity, however, in cold water (4° to 14° C.). Two additional factors suggest that the Cladocopa are essentially a cold-water group: 1) *Polycope orbicularis* has been found in glacial beds at many localities in Scotland; 2) four specimens of *Polycope orbicularis* obtained at a point 0.5 meter below the top of a sediment core collected from the mid-Atlantic ridge at a depth of 1280 meters were associated not only with cold-water ostracodes (Tressler, 1942, p. 97), but also with species of foraminifera which indicate that the water at the time when the *Polycope* lived was as cold as or colder than present-day temperatures (Cushman and Henbest, 1942, p. 41).

#### Salinity

Cladocopa have been reported from waters having a salinity as low as 30 parts per thousand (Elofson, 1941, p. 245). One of the Bahamian specimens here

described was collected in water having a salinity of 42 parts per thousand. It seems reasonably safe to conclude, on the basis of known distribution, that Cladocopa are usually restricted to normal marine salinities — 30 to 40 or 45 parts per thousand — as delineated by Dahl (1956).

#### Depth

The deepest reported occurrences of cladocopids are 2600 meters for *Polycope trigonalis* Chapman, obtained from a locality near Tasmania (Chapman, 1919), and 1280 meters for *Polycope orbicularis* G. O. Sars, collected from the top of the "Faraday Hills," in the mid-Atlantic ridge (Tressler, 1942). Cladocopids are most commonly found, however, in water shallower than 500 meters, and the Bahamian specimens were collected in water only 1 to 3 meters deep. Tressler (1954) reported shells of *Polycope orbicularis* recovered from bottom samples taken at depths between 128 and 1867 meters in the Gulf of Mexico.

#### Bottom-type

Cladocopids have been collected from sand, sandy mud, mixed sand and shells, oyster beds, shell beds, shell debris, oyster debris, calcareous algae, loose mud, coarse sand, oyster detritus, and sand with a thin mud cover. According to Elofson (1941, p. 246), the most widespread species, *Polycope orbicularis*, is not found on clean sand bottoms. As other species of *Polycope* are present there, however, a bottom preference may exist on the species level.

### PALEOECOLOGICAL VALUE OF THE CLADOCOPA

The shells of cladocopids are not strongly calcified, and because of this factor they are not readily preserved. The paleoecological value of the Cladocopa is therefore limited. Fossils of this group may indicate water of normal salinity (30 to 40 or 45 parts per thousand) at the time of deposition. The occurrence of a diverse or abundant fossil cladocopid fauna suggests cold water (4° to 14° C.), and generally suggests depths shallower than 500 meters.

### EVOLUTIONARY ASPECTS OF THE PRESENT STUDY

An anterior sinus often occurs in the shells of the Myodocopa and Cladocopa, suborders whose members are usually excellent swimmers. Conversely, such a sinus is absent from the Podocopa and Platycopa, suborders whose members are mostly non-swimmers. It may therefore be assumed that an indentation (sinus) on the anterior portion of the shell is an adaptation permitting more efficient swimming, the sinus probably permitting greater freedom of the swimming appendages. The anterior

concavity that is characteristic of many Recent forms is absent in Jurassic Cladocopa; this suggests that the concavity may have been a late acquisition. If so, the development of this feature may account for the explosive increase in the number of species in Recent times. About forty-one species are known in existing seas, as compared with only one in the Pleistocene and two in the Jurassic. The development of a sinus may also have contributed to the spread of this group away from Europe, which seems to have been the principal dispersal center in the past, as well as at present.

It is also possible that the Jurassic forms are not Cladocopa, and that the Cladocopa in their present form originated in the Pleistocene. Ostracodes definitely assignable to the Cladocopa have been found only in the Pleistocene and Recent. This hypothesis would account for the apparent absence of Cladocopa in the Cretaceous, from which only one questionable form has been recorded, and in the Tertiary. Cladocopa were probably either very rare or non-existent during the Paleozoic, or possessed shells that were less readily preservable than the shells of more recent forms.

#### SYSTEMATICS

Order OSTRACODA Latreille

Suborder CLADOCOPA G. O. Sars

Family POLYCOPIDAE G. O. Sars, 1866

Genus POLYCOPE G. O. Sars, 1866

***Polycope bahamaensis* Kornicker, new species**

Text-figure 3A-K

**Description:** Female: Shell elliptical in lateral view, but ventral edge with less curvature than dorsal edge. Greatest height a little behind the middle. Anterior distinctly bowed in middle, with a short, downward-pointing spine in center of indentation. Right valve with two small projections on posterodorsal edge; these are not present on left valve. Anteroventral edge of shell bears many small spinules, whose tips do not extend past shell margin. Shell thin, pellucid; surface smooth and without ornamentation. Anterior antennae with four joints; ultimate joint bears three long and two short setae; second joint provided with one seta in the middle of the upper edge. Exopodite of second antennae eight-jointed; endopodite three-jointed. Distal corners of caudal lamellae project downward; unfortunately, the remainder of this appendage was lost in dissection.

Male: Shell similar to female except small spine not observed above bowed anterior edge of right valve. First antennae with only four setae on ultimate joint, three long and one short, otherwise same as female. Right caudal lamella armed with seven claws that gradually

diminish in length proximally. Only two claws observed on left caudal lamella of the only male examined.

**Dimensions:** Female: Length 0.31 mm.; height 0.26 mm.; width 0.14 mm. Male: Length 0.30 mm.; height 0.24 mm. The female specimen is designated as the holotype: Columbia University no. 28,627 (shell).

**Discussion:** *Polycope bahamaensis* closely resembles *Polycope frequens* G. W. Müller, *Polycope dispar* G. W. Müller, and *Polycope fragilis* G. W. Müller. The presence of two small projections on the posteroventral edge of the right valve distinguishes *Polycope bahamaensis* from these species.

**Remarks:** The only two specimens of this species which have been collected were recovered from sand which had been dry for six months. Because of this factor, the appendages were stiff and the dissection not very satisfactory.

**Sample location:** The Bimini Islands are situated in the northeastern part of the Great Bahama Bank and are approximately fifty miles due east of Miami, Florida. The male specimen was collected in North Sound, a small body of water formed by the junction of North and East Bimini which has restricted connection with the ocean. The female specimen was collected at a locality a few hundred yards east of South Bimini.

**Ecology:** The male was collected in water 2 to 3 meters deep, with a salinity of 37 parts per thousand and a temperature of 29.2° C. The substrate consists of rock covered by 2 feet of calcareous sand supporting patchy growths of *Thalassia* grass and the alga *Laurencia*. The female was collected in water 1 meter deep, with a salinity of 42 parts per thousand and a temperature of 29–30° C. The bottom consists of calcareous sand supporting sparse *Thalassia*. Current velocities are low at both localities. The area from which the male was obtained supports a diverse and abundant ostracode community, whereas that from which the female was collected contains few ostracodes.

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# DISTRIBUTION OF CLADOCOPA



TEXT-FIGURE 3

*Polycope bahamaensis* Kornicker, n. sp. A-H, female (holotype): A, outline of left valve, interior,  $\times 120$ ; B, right valve, interior,  $\times 120$ ; C, maxilla,  $\times 576$ ; D, first antenna,  $\times 576$ ; E, right valve, exterior,  $\times 120$ ; F, posteroventral edge of right valve, exterior,  $\times 576$ ; G, dorsal view of carapace,  $\times 120$ ; H, anterior view of carapace,  $\times 120$  (spines not shown); I-K, male: I, right caudal lamella,  $\times 576$ ; J, left caudal lamella,  $\times 576$ ; K, second antenna,  $\times 576$ .



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