Biological Studies of the Bermuda Ocean Acre: Planktonic Ostracoda

LOUIS S. KORNICKER, SHELDON WIRSING, and MAURA McMANUS

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ABSTRACT

Kornicker, Louis S., Sheldon Wirsing, and Maura McManus. Biological Studies of the Bermuda Ocean Acre: Planktonic Ostracoda. *Smithsonian Contributions to Zoology,* number 223, 34 pages, 20 figures, 9 tables, 1976.—Planktonic Ostracoda from depths of surface to 1170 m collected aboard the Research Vessels *Trident, Albatross IV,* and USNS *Sands* during 1967 to 1970 on Ocean Acre Cruises 1, 7, 9, and 10 are studied with main emphasis on Cypridinacea and on Cruise 10. The data suggest that the cypridinid species *Macrocypridina castanea* and the Halocyprididae migrate upward nightly. The collections indicate that *M. castanea* is primarily an inhabitant of the bathypelagic zone, and that *G. muelleri* is primarily an inhabitant of the bathypelagic and upper abyssalpelagic zones. Halocyprids were collected at all depths but occurred in the greatest frequency in the epipelagic zone. The reported upper temperatures range of *G. muelleri* is increased by 10°, to 14.9°C by the distribution of the species in samples from Cruise 10. The stomach contents of *M. castanea* indicate that the species is a predator. Ovigerous females of *M. castanea* have previously been reported from collections made during May and July; the present cruises show that ovigerous females also are present during June, early September, late October, and early November. Reproduction may be less during winter months.

The phenomenon of the swallowing of the bristles of the 1st antenna by specimens of *M. castanea* is studied, and it is suggested that this may take place during the throes of being captured or killed. Swallowing of bristles of the 2nd antenna by this species is reported for the first time. SEM studies of *M. castanea* and *G. muelleri* reveal that both species bear lateral glandular fields on the upper lips in addition to previously reported anteroventral fields, and that the comb teeth of the 7th limbs bear terminal pores. The shells of both species have pores and are laminated. The copulatory organ of the adult male *M. castanea* has pores in the clawlike spine of the anterior proximal lobe and at the tip of the 2nd joint of the posterior, distal lobe.

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Contents

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Introduction

The Project "Ocean Acre" is a group effort of scientists representing the University of Rhode Island, the National Marine Fisheries Service, and the Smithsonian Institution. The object of the project is to make a comprehensive study of the biology and oceanography in the upper 1000 m of water within a one degree square southeast of Bermuda with its center at 32°N, 64°W (Roper et al., 1970). The present paper is concerned with ostracodes from Cruises 1 and 10, and in a few samples from Cruises 7 and 9 (see "Station Data").

Our analyses of distribution are based almost completely on samples collected during Cruise 10 in discrete depth sampling equipment, because more discrete depth samples were collected during that cruise. The distribution of ostracodes captured in samples collected during the other cruises we studied is consistent with the distributions observed on Cruise 10.

The samples contained 2 species in the suborder Myodocopina: *Macrocypridina castanea* (Brady, 1897) sensu Poulsen (1962:119), and *Gigantocypris muelleri* Skogsberg, 1920; and many species in the suborder Halocypridina. The latter were grouped under the category Halocyprididae in the present paper, and were not identified further.

The specimens of *M. castanea* and *G. muelleri* provided the opportunity to examine in detail the morphology of the carapace, upper lip, and 7th limb of these species using the scanning electron microscope.

Acknowledgments.—We thank Mr. Michael J. Sweeney and Mr. Charles Karnella, Smithsonian Institution, for their assistance in obtaining station data and background information concerning the Ocean Acre Program. The collections were made with the financial support of the Naval Underwater Systems Center, Contract No. N00140–70–C–0307. We are grateful to Dr. Clyde F. E. Roper and Dr. Martin V. Angel for reviewing the manuscript. The assistance of Mr. Walter R. Brown and Miss Mary J. Mann, who operated the scanning electron microscope is acknowledged. Freeze-drying of specimens for photography was done in the laboratory of Mr. Rolland Hower, Smithsonian Institution. We also thank the numerous individuals aboard the R/V *Trident*, R/V *Albatross IV*, and R/V USNS *Sands*, who collected the specimens upon which this paper is based. The specimens were sorted by personnel at the Smithsonian Oceanographic Sorting Center. We thank Mrs. Mary Frances Bell of the Smithsonian Institution Press for editing and preparing the manuscript and illustrations for publication.

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Methods

The attempt was made to take 4 samples during each trawling period of about 1 hour using a 10-ft. Isaacs-Kidd Midwater trawl with a cod-end Discrete-Depth Plankton Sampler. All gates were left open and no sample was obtained until the desired depth was reached. Then, the rear gate was closed forming a chamber. After 1 hour, the 2nd gate was closed isolating the 1st sample, and forming a new collection chamber. This was repeated for the 3rd chamber. When the final gate was closed isolating the 3rd chamber, the gear was raised to the surface providing the 4th sample, which is called the oblique sample. For details concerning the mechanics and operation of the discrete-depth sampler see Aron et al. (1964) and Bourbeau et al. (1966).

The sample collected in the 1st chamber is designated "A," the 2nd chamber "B," the 3rd chamber "C," and the oblique sample "M." Samples labeled with "P" are oblique samples combined with 1 or more discrete-depth samples, due to a malfunction of the instrument. Samples labeled with "N" are open net samples.

Information concerning methods may be found in a series of reports to the Naval Underwater Systems Center by Roper et al. (1970), Gibbs et al. (1971), Brown (1971), and Brown and Brooks (1974).

For comparison purposes the number of ostracodes per "standard volume" was calculated for each station.

$$\text{Number of ostracodes per standard volume} = \frac{\text{Number of ostracodes in samples A+B+C}}{3} \times \frac{\text{3 knots}}{\text{ship's speed (knots)}}$$

Most of the ostracodes, especially the halocyprids, escaped through the netting of the Isaac Kidd trawl and were not captured in the discrete-depth sampler. Therefore, it has been necessary to assume in the distributional calculations herein that the number captured in the discrete-depth sampler is representative of the number that entered the trawl.

Station Data

Research Vessel *Trident*, Cruise 1, October and November 1967

Station 1-3B; 26 October 1967; 32°16′N, 64°25′W; 320–478 m; 2152–2213 EST; whole sample; discrete-depth sampler (second chamber).
Halocyprididae: 1

Station 1-4B; 27 October 1967; 32°18′N, 64°20′W; 125–150 m; 0023–0053 EST; whole sample; discrete-depth sampler (second chamber).
Macrocypridina castanea: 2

Station 1-9A; 27–28 October 1967; 32°33′N, 64°21′W; 125 m; 2307–0007 EST; whole sample; discrete-depth sampler (first chamber).
Macrocypridina castanea: 1

Station 1-9C; 28 October 1967; 32°33′N, 64°21′W; 75 m; 0015–0115 EST; whole sample; discrete-depth sampler (third chamber).
Halocyprididae: 1

Station 1-11A; 28 October 1967; 32°37′N, 64°10′W; 200 m; 0550–0620 EST; whole sample; discrete-depth sampler (first chamber).
Macrocypridina castanea: 1

Station 1-15A; 28 October 1967; 32°46′N, 64°00′W; 420–700 m; 2003–2103 EST; whole sample; discrete-depth sampler (first chamber).
Macrocypridina castanea: 1

Station 1-15M; 28 October 1967; 32°46′N, 64°00′W; 0–283 m; 2232–2308 EST; whole sample; oblique sampler from depth to surface (last chamber).
Macrocypridina castanea: 2

Station 1-16A; 29 October 1967; 32°44′N, 63°42′W; 275–300 m; 0337–0437 EST; whole sample; discrete-depth sampler (first chamber).
Macrocypridina castanea: 1

Station 1-16B; 29 October 1967; 32°44′N, 63°42′W; 150–275 m; 0437–0458 EST; whole sample; discrete-depth sampler (second chamber).
Macrocypridina castanea: 3

Station 1-16C; 29 October 1967; 32°44′N, 63°42′ W; 175 m; 0458–0558 EST; whole sample; discrete-depth sampler (third chamber).
Macrocypridina castanea: 3

Station 1-18B; 30 October 1967; 32°10′N, 63°48′W; 130 m; 0035–0135 EST; whole sample; discrete-depth sampler (second chamber).
Macrocypridina castanea: 1

Station 1-18C; 30 October 1967; 32°10′N, 63°48′W; 100 m; 0145–0245 EST; whole sample; discrete-depth sampler (third chamber).
Macrocypridina castanea: 2

Station 1-18M; 30 October 1967; 32°10′N, 63°48′W; 0–100 m; 0245–0255 EST; whole sample; oblique sampler from depth to surface (last chamber).
Macrocypridina castanea: 1

Station 1-19A; 30 October 1967; 32°09′N, 63°59′W; 130–175 m; 0338–0438 EST; whole sample; discrete-depth sampler (first chamber).
Macrocypridina castanea: 2

Station 1-31N; 1-2 November 1967; 32°14′N, 63°26′W; 0–1500 m; 0030–0230 EST; whole sample; open net sampler.
Macrocypridina castanea: 3

Research Vessel *Albatross IV*, Cruise 7, September 1969

Station 7–15N; 8 September 1969; 32°21′N, 63°29′W; 0–450 m; 2108–2309 EST; part sample; open net sampler.
Macrocypridina castanea: 2

Station 7–19N; 9 September 1969; 32°42′N, 63°49′W; 0–750 m; 0746–0946 EST; part sample; open net sampler.
Macrocypridina castanea: 1

Research Vessel USNS *Sands*, Cruise 9, March 1970

Station 9–12N; 19 March 1970; 32°00′N, 64°00′W; 0–55 m; 0452–0632 EST; part sample; open net sampler.
Halocyprididae: 1

Station 9–21N; 20 March 1970; 31°46′N, 63°47′W; 0–950 m; 0035–0345 EST; part sample; open net sampler.
Gigantocypris muelleri: 1

Station 9–28N; 22 March 1970; 32°07′N, 63°32′W; 0–700 m; 1320–1635 EST; part sample; open net sampler.
Halocyprididae: 1

Research Vessel USNS *Sands*, Cruise 10, June 1970

Station 10–1N; 1 June 1970; 32°00′N, 64°29′W; 0–925 m; 1530–1830 EST; one-fourth sample; open net sampler; ship speed 3 knots.
Macrocypridina castanea: 7 (3 ovigerous ♀)
Halocyprididae: 153

Station 10–2B; 1 June 1970; 32°13′N, 64°23′W; 100 m; 2105–2205 EST; whole sample; discrete-depth sampler (second chamber); ship speed 3 knots.
Macrocypridina castanea: 1 juvenile (lost)
Halocyprididae: 3

Station 10–3C; 2 June 1970; 32°14′N, 64°13′W; 200 m; 0615–0715 EST; whole sample; discrete-depth sampler (third chamber); ship speed 4 knots.
Halocyprididae: 1

Station 10–4A; 2 June 1970; 32°18′N, 64°12′W; 800 m; 1455–1555 EST; whole sample; discrete-depth sampler (first chamber); ship speed 3 knots.
Macrocypridina castanea: 1

Station 10–4B; 2 June 1970; 32°18′N, 64°12′W; 800 m; 1555–1655 EST; whole sample; discrete-depth sampler (second chamber); ship speed 3 knots.
Macrocypridina castanea: 1
Halocyprididae: 2

Station 10–4C; 2 June 1970; 32°18′N, 64°12′W; 800 m; 1655–1755 EST; whole sample; discrete-depth sampler (third chamber); ship speed 3 knots.
Macrocypridina castanea: 3 (one ovigerous female)
Halocyprididae: 1

Station 10–5A; 2 June 1970; 32°33′N, 64°04′W; 600 m; 2030–2130 EST; whole sample; discrete-depth sampler (first chamber); ship speed, 3 knots.
Halocyprididae: 2

Station 10–5B; 2 June 1970; 32°33′N, 64°04′W; 600 m; 2130–2330 EST; whole sample; discrete-depth sampler (second chamber); ship speed 3 knots.
Macrocypridina castanea: 8

Station 10–5M; 2 June 1970; 32°33′N, 64°04′W; 0–600 m; 2330–0030 EST; whole sample; oblique sampler from depth to surface (last chamber); ship speed 3 knots.
Macrocypridina castanea: 3
Halocyprididae: 1

Station 10–6B; 3 June 1970; 32°22′N, 64°14′W; 290 m; 0400–0500 EST; whole sample; discrete-depth sampler (second chamber); ship speed 3 knots.
Macrocypridina castanea: 1

Station 10–7A; 3 June 1970; 32°16′N, 64°21′W; 1000–1120 m; 0725–0825 EST; whole sample; discrete-depth sampler (first chamber); ship speed 2 knots.
Macrocypridina castanea: 5 (2 ovigerous)

Station 10–7B; 3 June 1970; 32°16′N, 64°21′W; 970–1060 m; 0825–0925 EST; whole sample; discrete-depth sampler (second chamber); ship speed 2 knots.
Macrocypridina castanea: 2 ovigerous ♀

Station 10–7M; 3 June 1970; 32°16′N, 64°21′W; 0–970 m; 0925–1037 EST; whole sample; oblique sampler from depth to surface (last chamber); ship speed 2 knots.
Macrocypridina castanea: 1 ovigerous female
Halocyprididae: 6

Station 10–8A; 3 June 1970; 32°02′N, 64°25′W; 90 m; 1305–1405 EST; whole sample; discrete-depth sampler (first chamber); ship speed 2 knots.
Halocyprididae: 3

Station 10–8B; 3 June 1970; 32°02′N, 64°25′W; 90 m; 1405–1505 EST; whole sample; discrete-depth sampler (second chamber); ship speed 2 knots.
Halocyprididae: 3

Station 10–9A; 3 June 1970; 31°56′N, 64°25′W; 55 m; 1550–1650 EST; whole sample; discrete-depth sampler (first chamber); ship speed 2 knots.
Halocyprididae: 1

Station 10–10B; 3 June 1970; 31°51′N, 64°19′W; 825 m; 2325–0025 EST; whole sample; discrete depth sampler (second chamber); ship speed 3 knots.
Macrocypridina castanea: 1
Gigantocypris muelleri: 1

Station 10–10M; 3 June 1970; 31°51′N, 64°19′W; 0–825 m; 0025–0125 EST; whole sample; oblique sampler from depth to surface (last chamber); ship speed 3 knots.
Macrocypridina castanea: 1
Halocyprididae: 1

Station 10–11A; 4 June 1970; 32°00′N, 64°16′W; 150 m; 0200–0300 EST; whole sample; discrete-depth sampler (first chamber); ship speed 3 knots.
Halocyprididae: 2

Station 10–11B; 4 June 1970; 32°00′N, 64°16′W; 150 m; 0300–0400 EST; whole sample; discrete-depth sampler (second chamber); ship speed 3 knots.
Halocyprididae: 2

Station 10–11M; 4 June 1970; 32°00′N, 64°16′W; 0–150 m; 0400–0420 EST; whole sample; oblique sampler from depth to surface (last chamber); ship speed 3 knots.
Halocyprididae: 1

Station 10–13B; 5 June 1970; 31°23′N, 64°46′W; 400 m; 0850–1050 EST; whole sample; discrete-depth sampler (second chamber); ship speed 4 knots.

Halocyprididae: 1

Station 10–14M; 5 June 1970; 31°09′N, 64°42′W; 0–200 m; 1615–1640; whole sample; oblique sampler from depth to surface (last chamber); ship speed 3 knots.

Halocyprididae: 1

Station 10–15B; 5 June 1970; 31°24′N, 64°46′W; 210 m; 1926–2020 EST; whole sample; discrete-depth sampler (second chamber); ship speed 3 knots.

Halocyprididae: 1

Station 10–15C; 5 June 1970; 31°24′N, 64°46′W; 210 m; 2020–2120 EST; whole sample; discrete-depth sampler (third chamber); ship speed 3 knots.

Halocyprididae: 1

Station 10–15M; 5 June 1970; 31°24′N, 64°46′W; 0–210 m; 2120–2137; one-half sample; oblique sampler from depth to surface (last chamber); ship speed 3 knots.

Halocyprididae: 1

Station 10–16A; 5 June 1970; 31°29′N, 64°49′W; 205 m; 2215–2315 EST; whole sample; discrete-depth sampler (first chamber); ship speed 3 knots.

Macrocypridina castanea: 1

Station 10–16C; 5 June 1970; 31°29′N, 64°49′W; 205 m; 0015–0115 EST; whole sample; discrete-depth sampler (third chamber); ship speed 3 knots.

Macrocypridina castanea: 2

Station 10–17A; 6 June 1970; 31°44′N, 64°57′W; 50 m; 0200–0300 EST; whole sample; discrete-depth sampler (first chamber); ship speed 4 knots.

Halocyprididae: 1

Station 10–17B; 6 June 1970; 31°44′N, 64°57′W; 50 m; 0300–0400 EST; one-half sample; discrete-depth sampler (second chamber); ship speed 4 knots.

Halocyprididae: 3

Station 10–17M; 6 June 1970; 31°44′N, 64°57′W; 0–50 m; 0500–0525 EST; one-half sample; oblique sampler from depth to surface (last chamber); ship speed 4 knots.

Halocyprididae: 1

Station 10–18A; 6 June 1970; 31°34′N, 64°55′W; 100 m; 0555–0620 EST; whole sample; discrete-depth sampler (first chamber); ship speed 4 knots.

Halocyprididae: 1

Station 10–19C; 6 June 1970; 31°25′N, 64°54′W; 1160–1170 m; 1215–1315 EST; whole sample; discrete-depth sampler (third chamber); ship speed 4 knots.

Macrocypridina castanea: 1

Station 10–19M; 6 June 1970; 31°25′N, 65°54′W; 0–1170 m; 1315–1405 EST; one-fourth sample; oblique sampler from depth to surface (last chamber); ship speed 4 knots.

Halocyprididae: 2

Macrocypridina castanea: 2

Station 10–20C; 6 June 1970; 31°14′N, 64°52′W; 520 m; 1800–1900 EST; whole sample; discrete-depth sampler (third chamber); ship speed 3 knots.

Macrocypridina castanea: 1

Halocyprididae: 2

Station 10–21N; 6 June 1970; 31°27′N, 64°49′W; 0–880 m; 2130–0030 EST; one-half sample; open net sampler; ship speed 3 knots.

Halocyprididae: 8

Station 10–23A; 7 June 1970; 31°45′N, 64°51′W; 630 m; 1322–1422 EST; whole sample; discrete-depth sampler (first chamber); ship speed 2 knots.

Halocyprididae: 1

Station 10–24A; 7 June 1970; 31°26′N, 64°50′W; 950–1080 m; 1855–1955 EST; whole sample; discrete-depth sampler (first chamber); ship speed 2 knots.

Macrocypridina castanea: 1

Station 10–24B; 7 June 1970; 31°26′N, 64°50′W; 1080 m; 1955–2055 EST; whole sample; discrete-depth sampler (second chamber); ship speed 2 knots.

Halocyprididae: 1

Station 10–24C; 7 June 1970; 31°26′N, 64°50′W; 1080 m; 2055–2155 EST; whole sample; discrete-depth sampler (third chamber); ship speed 2 knots.

Macrocypridina castanea: 2 ovigerous females

Gigantocypris muelleri: 1

Station 10–24M; 7 June 1970; 31°26′N, 64°50′W; 0–1080 m; 2155–2320 EST; whole sample; oblique sampler from depth to surface (last chamber); ship speed 2 knots.

Macrocypridina castanea: 2 (1 ovigerous female)

Halocyprididae: 3

Station 10–26P; 8 June 1970; 31°41′N, 64°50′W; 0–170 m; 1125–1325 EST; whole sample; oblique sampler from depth to surface plus discrete-depth sampler; ship speed 3 knots.

Halocyprididae: 4

Station 10–27B; 8 June 1970; 31°30′N, 64°53′W; 110 m; 1910–1930 EST; whole sample; discrete-depth sampler second chamber); ship speed 3 knots.

Halocyprididae: 1

Station 10–28N; 8 June 1970; 31°30′N, 64°53′W; 0–580 m; 2100–0000 EST; one-half sample; open net sampler; ship speed 3 knots.

Macrocypridina castanea: 1

Halocyprididae: 1

Station 10–29M; 9 June 1970; 31°10′N, 64°57′W; 0–430 m; 0415–0443 EST; whole sample; oblique sampler from depth to surface (last chamber); ship speed 3 knots.

Halocyprididae: 2

Station 10–31A; 9 June 1970; 31°17′N, 64°55′W; 300 m; 0730–0830 EST; whole sample; discrete-depth sampler (first chamber); ship speed 3 knots.

Macrocypridina castanea: 1

Station 10–34C; 9 June 1970; 31°33′N, 64°46′W; 520 m; 2305–0005 EST; whole sample; discrete-depth sampler (third chamber); ship speed 3 knots.

Macrocypridina castanea: 1

Station 10–35A; 10 June 1970; 31°24′N, 64°48′W; 360 m; 0215–0315 EST; whole sample; discrete-depth sampler (first chamber); ship speed 3 knots.

Macrocypridina castanea: 2

Halocyprididae: 1

Station 10–36A; 10 June 1970; 31°14′N, 64°52′W; 630–700 m; 0710–1010 EST; one-fourth sample; discrete-depth sampler (first chamber); ship speed 3 knots.

Halocyprididae: 4

Station 10–36M; 10 June 1970; 31°14′N, 64°52′W; 0–700 m; 1010–1055 EST; whole sample; oblique sampler from

depth to surface (last chamber); ship speed 3 knots.
Halocyprididae: 1
Station 10-37N; 10 June 1970; 31°30′N, 64°53′W; 0–480 m; 1500–1800 EST; one-half sample; open net sampler; ship speed 3 knots.
Halocyprididae: 2
Station 10-38N; 10 June 1970; 31°45′N, 64°48′W; 0–300 m; 2140–0040 EST; whole sample; open net sampler; ship speed 3 knots.
Macrocypridina castanea: 4 (1 ovigerous female)
Halocyprididae: 3

Diel Migration

The literature concerning the diel migration of ostracodes has been reviewed by Angel (1969:515, 516; 1972:217), who also reported occurrences of migration in some species of *Conchoecia,* and lack of migration, or reversal, in others. The distribution of ostracodes arranged according to increasing depth, and adjusted to a standard volume of water filtered by the discrete sampler, is given in Table 1.

Only 67% of the samples collected on Cruise 10 during daylight hours contained ostracodes compared to 91% during the night (Table 2). This suggests that the depths sampled, 50–1170 m, recruited ostracodes from greater depths during the night. This is less apparent for the halocyprids, which only increased from 44% to 55%, than for *Macrocypridina castanea,* which increased from 33% to 73%. No specimens of *Gigantocypris muelleri* were collected during the day, but because specimens were collected at only 2 samples during the night, the distribution could be the result of sample error.

The night and day distribution of ostracodes at depths of 50–520 m and 600–1170 m are compared in Table 3. In the upper water layer the percentage of samples with ostracodes increased from 60 during daylight hours to 87.5 during the night, indicating that ostracodes were recruited from below during the night. At the same time, the percentage of samples with ostracodes at depths of 600–1170 m increased from 75 during the day to 100 during the night, indicating that ostracodes were also recruited from below. Whether the ostracodes recruited in the upper layer were those that lived in the lower layer during the day or came from deeper water is not known.

The percentage of samples in the upper layer containing halocyprids did not change from day to night, but in the lower layer, the percentage increased from 37.5 during the day to 67 during the night (Table 3). The percentage of samples with *M. castanea* increased in both layers during the night (Table 3). No specimens of *G. muelleri* were collected in the upper layer, and the species was collected during the night only in 2 samples in the lower layer (Table 3).

Relationship between Depth and Frequency of Capture

Ostracodes were captured at all depths sampled. The frequency of capture varied from 42% in the epipelagic zone (50–200 m) to 86% in the bathypelagic zone (1001–2000 m) (Table 4). In the mesopelagic zone (201–1000 m) the frequency of capture was 46%.

Macrocypridina castanea.—Poulsen (1962:135) concluded from the frequency of *Macrocypridina castanea* collected in open nets in the Atlantic Ocean that the species is rare in the upper 100 m, gradually increases in frequency between 100 and 1000 m, and reaches its greatest frequency between 1000 and 3500 m. He (p. 136) suggested that the main habitat of the species may be between depths of 1500 m and 3000 m. The shallowest depth at which the species was captured in the collections reported on by Poulsen (p. 135) was about 35 m. A few larvae were reported by Deevey (1968:18) in samples collected at depths of 300–500 m in the Sargasso Sea off Bermuda. Most of her collections were from depths of 500 m to the surface. Angel (1969:540), who collected planktonic ostracodes at 50-m intervals to a depth of 950 m off the Canary Islands, captured most specimens of *M. castanea* in a day haul from 300 m, with a few individuals being caught in samples down to depths of 800 m. During the night the species was most abundant at depths of 220–250 m, and its range was 150–500 m. He concluded that his data suggested that Poulsen (1962) overestimated the depths at which *M. castanea* occurs. Deevey and Brooks (1971:938) collected plankton in the upper 2000 m in Sargasso Sea off Bermuda, and reported *Macrocypridina* within the upper 1000 m.

The frequency of capture of *M. castanea* in the present collections is compared with that reported by Poulsen (1962:135) in Table 5. The frequency of capture increased more rapidly from 50 m to 1000 m in our collections than it did in the collec-

TABLE 1.—Distribution of ostracodes (number per standard volume) arranged according to increasing depth (night = 2019–0410 hours; dawn = 0410–0610; day = 0610-1819; dusk = 1819–2019; standard volume water passing in one hour through a single net (one-third of 3-part sampler) of discrete sampler at a speed of 3 knots; partly picked samples extrapolated to whole = *)

Station number	Ship's speed (knots)	Date (1970)	Time period (hours)	Number of samples	Depth (m)	*Macrocypridina castanea*	*Gigantocypris muelleri*	Halocyprididea
10-17M	4	6 Jun	night, 0500-0525	1	0-50	0	0	0.75
* 10-17A,B	4	6 Jun	night, 0200-0400	2	50	0	0	2.63
10-9	2	3 Jun	day, 1550-1750	2	55	0	0	0.75
10-8	2	3 Jun	day, 1305-1505	2	90	0	0	4.50
* 10-2	3	1 Jun	night, 2205-0005	2	100	0.50	0	1.50
10-18	4	6 Jun	day, 0555-0645	2	100	0	0	0.38
10-27	3	8 Jun	dusk, 1910-1950	2	110	0	0	0.50
10-11	3	4 Jun	night, 0200-0400	2	150	0	0	2.00
10-32	4	9 Jun	day, 1315-1615	3	170	0	0	0
10-3	4	2 Jun	dawn, 0415-0715	3	200	0	0	0.24
10-14	3	5 Jun	day, 1315-1615	3	200	0	0	0
10-16	3	5 Jun	night, 2215-0115	3	205	1.00	0	0
10-15	3	5 Jun	dusk, 1820-2120	3	210	0	0	0.66
10-6	3	3 Jun	night, 0300-0500	2	290	0.50	0	0
10-31	3	9 Jun	day, 0730-1030	3	300	0.33	0	0
* 10-33A	3	9 Jun	day, 1715-1800	1	300-340	0	0	0
10-33B	3	9 Jun	dusk, 1800-1845	1	340	0	0	0
10-33C	3	9 Jun	dusk, 1845-1930	1	340-350	0	0	0
10-35	3	10 Jun	night, 0215-0415	2	360	1.00	0	0.50
10-35C	3	10 Jun	dawn, 0415-0515	1	360-550	0	0	0
10-13	4	5 Jun	day, 0750-1050	2	400	0	0	0.38
10-29	3	9 Jun	night, 0115-0215	1	430	0	0	0
10-20A	3	6 Jun	day, 1600-1700	1	490-520	0	0	0
10-20	3	6 Jun	day, 1700-1900	2	520	0.50	0	1.00
10-34	3	9 Jun	night, 2105-0005	3	520	0.33	0	0
10-5	3	2 Jun	night, 2030-2330	2	600	4.00	0	1.00
10-23	2	7 Jun	day, 1322-1622	3	630	0	0	0.50
* 10-36A	3	10 Jun	day, 0710-1010	1	630-700	0	0	16.00
10-4	3	2 Jun	day, 1455-1755	3	800	1.66	0	1.00
10-10	3	3 Jun	night, 2225-0025	2	825	0.50	0.50	0
10-19A	4	6 Jun	day, 1015-1115	1	880-1050	0	0	0
10-24A	2	7 Jun	dusk, 1855-1955	1	950-1080	1.50	0	0
10-7B	2	3 Jun	day, 0825-0925	1	970-1060	3.00	0	0
10-7A	2	3 Jun	day, 0725-0825	1	1000-1120	7.50	0	0
10-19B	4	6 Jun	day, 1115-1215	1	1050-1160	0	0	0
10-24	2	7 Jun	night, 1955-2155	2	1080	1.50	0.75	0.75
10-19C	4	6 Jun	day, 1215-1315	1	1160-1170	0.75	0	0

TABLE 2.—Comparison of night and day distribution of ostracodes from Cruise 10 (samples collected at dusk and dawn not included; discrete samples collected at same station and depth are grouped together and considered to be 1 sample, as in Table 1)

Comparison	Halocyprididae	*Macrocypridina castanea*	*Gigantocypris muelleri*	Ostracoda
Day				
Samples with specimens..........	8	6	0	12
Samples without specimens.......	10	12	18	6
% of samples with specimens.....	44	33	0	67
Night				
Samples with specimens..........	6	8	2	10
Samples without specimens.......	5	3	9	1
% of samples with specimens.....	55	73	18	91

TABLE 3.—Comparison of night and day distribution of ostracodes from Cruise 10 at depths of 50–520 m and 600–1170 m (samples collected at dusk and dawn not included; discrete samples collected at same station and depth are grouped together and considered to be 1 sample, as in Table 1)

Comparison	Halocyprididae	*Macrocypridina castanea*	*Gigantocypris muelleri*	Ostracoda
Depth: 50-520 m				
Day				
Samples with specimens..........	5	2	0	6
Samples without specimens.......	5	8	10	4
% of samples with specimens.....	50	20	0	60
Night				
Samples with specimens..........	4	5	0	7
Samples without specimens.......	4	3	8	1
% of samples with specimens.....	50	62.5	0	87.5
Depth: 600-1170 m				
Day				
Samples with specimens..........	3	4	0	6
Samples without specimens.......	5	4	8	2
% of samples with specimens.....	37.5	50	0	75
Night				
Samples with specimens..........	2	3	2	3
Samples without specimens.......	1	0	1	0
% of samples with specimens.....	67	100	67	100

TABLE 4.—Frequency distribution (percent of samples) of ostracodes in depth zones

Depth zone	Number of samples	*Macrocypridina castanea*	*Gigantocypris muelleri*	Halocypridae	Ostracoda
Epipelagic zone (50-200 m)	26	4	0	42	42
Mesopelagic zone (201-1000 m)	39	31	3	26	46
Bathypelagic zone (1001-2000 m; 1170 m maximum depth sampled on Cruise 10)	7	71	14	14	86

tions of Poulsen. Because our samples were not collected below 1170 m, it is not possible to determine whether or not the species is more abundant at greater depths. The shallowest depth at which *M. castanea* was found in our collections is 100 m. Our collections suggest that *M. castanea* is primarily an inhabitant of the bathypelagic zone (Table 4).

Gigantocypris muelleri.—Poulsen (1962:83) reported this species from depths of 400 m to 3000 m in the Atlantic Ocean. He concluded that his data indicated that the species is found closer to the surface in the northern boreal parts of the Atlantic than in the tropical and subtropical parts, and that mature specimens are generally restricted to deeper water than are the juveniles. Skogsberg (1920:218) reported the species at a depth of 150 m. In the present collections, *G. muelleri* was collected only in night samples on Cruise 10, at depths of 825 m and 1080 m. Only 2 specimens were captured, an instar IV female at 1080 m, and an adult female at 825 m. This species would appear to be primarily an inhabitant of the bathypelagic and upper abyssalpelagic zones (Table 4).

HALOCYPRIDIDAE.—Halocyprids were collected at all depths sampled but occurred in the greatest frequency in the epipelagic zone (Table 4).

Relationship between Water Temperature and Salinity and Ostracode Distribution

The temperatures and salinities obtained at 3 stations on Cruise 10 are given in Table 6. The temperatures and salinities are probably close to those at the sample stations at which ostracodes were collected. The temperature decreased in the depth range of discrete samples from about 20°C at 50 m to about 6°C at 1104 m. The salinity between the same depth limits decreased from 36.42 parts per thousand to 35.01 parts per thousand. Halocyprids were collected at all temperatures and salinites. Specimens of *M. castanea* were collected between temperatures of about 18.5°C and 5.9°C, and salinities of about 36.5–35.0 parts per thousand. Specimens of *G. muelleri* were collected between temperatures of about 10°C and 7°C, and salinites of about 35.4–35.03 parts per thousand.

Poulsen (1962:136) reported the temperature range of *M. castanea* to be 3.0°–18.9°C based on observations made simultaneous to hauls. Deevey (1968:18) reported 2 larvae collected at 300–400 m at a maximum temperature of 17.6°C. The occurrences of *M. castanea* in the collections from Cruise 10 support the observations of Poulsen and Deevey.

Poulsen (1962:84) reported the temperature range of *G. muelleri* to be 2.6°–4.9°C and the salinity range to be 34.7–35.4 parts per thousand. The upper temperature range is increased to 10°C by the distribution of the species in samples from Cruise 10. The salinities in Cruise 10 fall within the range reported by Poulsen.

Food Requirements of Planktonic Ostracodes

Angel (1970:734) observed that halocyprids feed on damaged specimens of any group in net hauls prior to preservation. The gut content of 15 species of *Conchoecia* was tabulated by Angel (1972:220). The guts contained crustacean parts, tintinnids, chaetognaths, radiolarians, coccolithophores, foraminifera, silicoflagellates, diatoms, as well as unidentifiable detritus. Lochhead (1968), who observed specimens in captivity, found them to feed

TABLE 5.—Distribution (percent of samples) of *Macrocypridina castanea*, at increasing depths, from *Dana* collections with open net (Poulsen, 1962:135) compared with Cruise 10 collections with discrete-depth sampler (depths are approximately those used by Poulsen)

Depth (m)	Dana Collections		Cruise 10 Collections	
	Number of samples	Percent with *M. castanea*	Number of samples	Percent with *M. castanea*
35........	288	0.0	1 *	0
35 - 99........	517	0.4	7	0
100 -199........	378	2.9	11	9.1
200 -349........	275	6.5	20	20.0
350 -999........	181	9.9	24	33.3
1000-1499........	57	15.8	7	85.7
1500-1999........	57	21.3	0	no data
2000-2499........	46	13.0	0	no data
2500-2999........	25	20.0	0	no data
3000-3500........	14	14.3	0	no data

*Sample 10-17M, 0-50 m.

predominantly on dead animals. In general, the halocyprids appear to feed on phytoplankton and zooplankton.

Cannon (1933:739) reported parts of a mysid in the gut of a specimen of *M. castanea*. We examined the gut content of 7 specimens of *M. castanea*, 3 adult females, 3 adult males, and 1 A–1 ?female (Table 7). Similar material was found in the stomachs of the juvenile and the adult males and females. The large size and whole condition of an adult male of the copepod *Temora* sp. and an adult male of the copepod *Euchaeta* sp. in the ostracode stomachs indicate that *M. castanea* is a predator. The length of the specimen of *Euchaeta* sp. is 4.5 mm; however, because the specimen was folded, the maximum length in the ostracode stomach was 2.7 mm. Two specimens of *M. castanea* had within their stomachs a fish scale, one measuring 1.26 mm by 1.16 mm, the other 2.47 mm by 1.56 mm. The presence of the scales suggests that the ostracodes ingest debris in the water. The size of the scales indicates that the fish from which they came would be too large to have been eaten whole by the ostracode. It is possible that the stomach contents are the result of ingestion that took place in the net during capture.

Cannon (1940:193) reported that *Gigantocypris* feeds on active prey and recorded the gut contents of several specimens as follows: *Sagitta*, somites of Brachyuran zoaea, the Copepods *Pleuromamma robusta* Dahl, *Pleuromamma* sp., and *Heterorhabdus*, and the half-digested remains of a small fish. The adult female and instar IV female of *G. Muelleri* collected on Cruise 10 were practically empty, and the small amount of material present was unrecognizable. An instar IV female from Cruise 9 had a full gut (Figure 20*d*), but the contents were not identified.

Reproduction of *Macrocypridina castanea*

Skogsberg (1920:296) reported ovigerous females in samples collected during May and July. In the present study ovigerous females were collected in early June (Cruise 10), early September (Cruise 7), and late October to early November (Cruise 1). Specimens of *M. castanea* were not present in collections from Cruise 9 made in March, but as only 3 samples were examined, one of which was too shallow to expect specimens of *M. castanea*, their absence could be due to sample error. Thus, ovigerous females are present from May through early November. Whether or not ovigerous females are present in December through April is not known. The samples collected in late October and early November contained only 13 percent ovigerous fe-

TABLE 6.—Changes of temperatures (°C) and salinities (‰) with increasing depth at three localities of Cruise 10 (data from Brown, 1971, Table 4)

Depth (m)	32°17.2'N, 64°09.5'W Temperature	Salinity	32°15'N, 64°19'W Temperature	Salinity	31°45'N, 64°50'W Temperature	Salinity
0	21.62	36.60	22.35	36.44	23.52	36.74
9	21.62	36.59	-	-	-	-
10	-	-	21.48	36.48	-	-
18	21.62	36.58	-	-	-	-
20	-	-	21.27	36.43	-	-
28	21.60	36.54	-	-	-	-
30	-	-	21.20	36.42	-	-
44	-	-	-	-	20.26	36.60
46	19.96	36.53	-	-	-	-
50	-	-	20.02	36.42	-	-
69	19.07	36.35	-	-	-	-
75	-	-	18.87	36.40	-	-
89	-	-	-	-	18.69	36.58
93	18.78	36.33	-	-	-	-
100	-	-	18.55	36.39	-	-
140	18.31	36.25	-	-	-	-
150	-	-	18.19	36.35	-	-
178	-	-	-	-	18.30	36.50
187	18.01	36.30	-	-	-	-
200	-	-	17.96	36.32	-	-
284	17.63	36.32	-	-	-	-
300	-	-	17.71	36.32	-	-
359	-	-	-	-	17.67	36.47
400	-	-	17.36	36.24	-	-
540	-	-	-	-	16.55	36.27
632	-	-	-	-	14.94	35.92
724	-	-	-	-	12.93	35.64
912	-	-	-	-	8.25	35.08
1104	-	-	-	-	5.88	35.01

males compared to 23 percent in June suggesting that reproduction may be less during winter months.

Skogsberg (1920:294) reported brood sizes of 50–75 eggs for *M. castanea*. Four specimens we examined contained 46–71 eggs, mean 60. The largest and smallest egg from a subsample of 4 eggs was measured in the 4 specimens (Table 8). Eggs without lateral eyes were in 3 specimens; the eggs ranged in diameter from 0.42 to 0.62 mm. Eggs

TABLE 7.—Stomach contents of *Macrocypridina castanea*

Specimen and sample number	Stomach Contents
151165, adult ♂ (10-1N).........	Crustacean appendages: euphausiid pleopods, copepod maxilla; Temora sp. ♂ (calanoid copepod); abundant red-brown material.
151578A, adult ♀ (10-38N).......	Crustacean appendages: euphausiid pleopod, euphausiid thoracic leg, calanoid copepod 1st & 2nd antennae, calanoid copepod mandible; fish scale (teleost) 1.26 x1.16 mm; halocyprid ostracodes; spines and setae.
151578B, a-1 ♀? (10-38N)........	Copepod parts: mandible, head region and apical spine of swimming legs, other unrecognizable parts; fish scale 1.56x2.47 mm.
151578C, adult ♀ (10-38N).......	Copepod Euchaeta - adult (whole) ♂, 4.5 mm (maximum length in stomach 2.7); crustacean eye.
135755A, adult ♀ (10-7A)........	Calanoid copepod parts; swimming legs, mandible, maxilliped?; euphausiid parts: pleopod, leg; unidentified setae and appendages.
135755B, adult ♀ (10-7A)........	Euphausiid pleopod; calanoid copepod parts: mandible, other mouthparts; unidentified claws and teeth.
151175, adult ♂ (10-19C)........	Calanoid copepod parts: antennae, maxilla and mouthparts.

TABLE 8.—Brood sizes and egg diameters of *Macrocypridina castanea*

Specimen (carapace length and height in mm)	Number of eggs	Range of diameter of 4 eggs (mm)	Comments
135755A (7.1, 5.0).........................	58	0.42-0.59	no eyes
135755B (6.5, 4.0).........................	46	0.39-0.50	no eyes
151179 (6.5, 4.4).........................	71	0.55-0.62	no eyes
151578C (7.0, 4.9).........................	63	0.60-0.75	lateral eyes present

with lateral eyes were in 1 specimen; the eggs ranged in size from 0.60 to 0.75 mm. Small eggs tend to be flattened on either side, and adhere to each other and to the body of the ostracode. Larger eggs are spherical, and tend to float away from each other and from the body of the ostracode.

Phenomenon of Swallowing Bristles of First Antenna

Skogsberg (1920:296) has been the only investigator to remark on the peculiar behavior of *M. castanea* in placing bristles of the 1st antenna into its mouth and stomach. He believed that the long bristles of the 1st antenna might be used for food collecting.

Skogsberg reported the swallowing phenomenon to take place in the majority of specimens he investigated, both males and females. We found it to take place in 7 of 16 specimens examined (Table 9). When they were not swallowed the 1st antennae assumed several positions: 1, folded back and completely inside the carapace; 2, folded back inside the carapace, but with posterior ends of antennae extending out the posterior gape of the carapace; 3, extending anteriorly out the anterior gape of incisur of the carapace.

Our studies indicate that males swallow their 1st

TABLE 9.—Frequency of swallowing bristles on 1st and 2nd antennae of *Macrocypridina castanea* (+ in mouth, − not in mouth)

USNM number	Sample number	Length (mm)	Height (mm)	Sex	1st antennae	2nd antennae
151165	10-1N	6.9	4.60	♂	+	-
151167A	10-5B	7.0	3.75	♂	+	-
151167B	10-5B	7.0	4.50	♂	+	-
151173	10-10M	6.9	4.30	♂	-	-
151175	10-19C	7.0	4.50	♂	+	-
151576	10-35A	6.4	4.50	♂	+	+
135755A	10-7A	7.1	5.00	♀	+	+
135755B	10-7A	6.5	4.40	♀	-	-
151179	10-24C	6.5	4.00	♀	-	-
151578A	10-38N	7.0	4.50	♀	-	-
151578C	10-38N	7.0	4.90	♀	-	-
151169	10-6B	2.6	1.90	juvenile	-	-
151174A	10-16C	4.5	3.10	juvenile	-	-
151174B	10-16C	3.9	3.00	juvenile	+	-
151176	10-20C	2.7	2.00	juvenile	-	-
151578B	10-38N	6.0	4.30	A-1 ♀?	-	-

antennae more than either females or juveniles, as shown below (from Table 9).

	Number of specimens examined	*Specimens swallowing antennae (%)*
Males	6	83
Females	5	20
Juveniles	5	20

In order to ascertain the position of the bristles in the stomach, an adult male was carefully dissected without disturbing the bristles inside the stomach. The bristles were curled as shown in Figure 1. In some specimens just the tips of bristles were inside the mouth, in others they were almost completely inserted. Usually, the bristles of both antennae were inserted, but on a few specimens, the bristles of only 1 limb were swallowed. On some specimens, the bristles were intimately entwined in the food.

On 2 specimens, an adult male and an adult female, a previously unreported phenomenon was observed. The specimens had swallowed the bristles of the exopodites of the 2nd antennae along with the bristles of the 1st antennae (Figure 7*a*,*b*). On all 16 specimens examined, the 2nd antennae had been withdrawn inside the carapace.

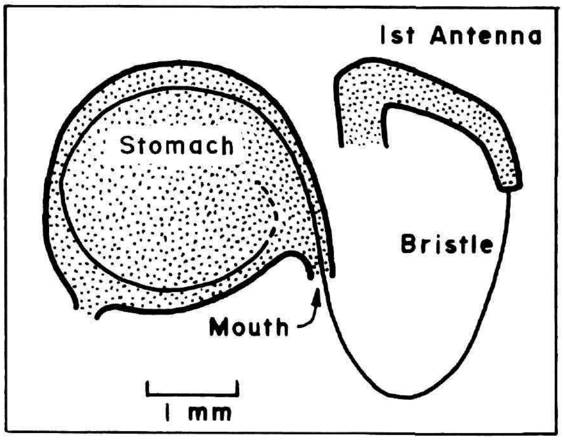

FIGURE 1.—*Macrocypridina castanea,* USNM 151167B, adult male, shell length 7.0 mm: camera lucida drawing showing position in gut of a bristle of the 1st antenna.

We examined bristles of the first antennae under the scanning electron microscope and could detect no differences between segments that had been inside and outside the stomach.

The reason for bristles of the 1st antenna being inside the stomach is not clear. We suggest that the ostracodes might swallow the bristles in the throes of being captured or killed. The few cases of the bristles of the 2nd antennae also being swallowed tend to support this contention, because without these the ostracode could not swim. The phenomenon has not been reported in any other species, indicating that this peculiar behavioral trait during capture might be rare.

Macrocypridina castanea (Brady, 1897)

FIGURES 1–14

Cypridina castanea Brady, 1897:88, pl. 16: figs. 1–4.—Müller, 1906:130, pl. 5: figs. 1,2, pl. 33: figs. 11–16, pl. 34: figs. 10–13; 1906a:13.—Fowler, 1909:220, 257, 279, 296, pl. 26: figs. 279–281.—Müller, 1912:14 [part].

Cypridina (Macrocypridina) castanea.—Skogsberg, 1920:281, figs. 47–51.

Macrocypridina castanea, sensu stricto.—Poulsen, 1962:120, figs. 61–67.—Hanai, 1974:118.

MATERIAL.—USNM 135751, 1 specimen from sample 10–4A; USNM 135752, 1 specimen from sample 10–4B; USNM 135753, 3 specimens from sample 10–4C; USNM 135754, 1 specimen from sample 10–5M; USNM 135755, 5 specimens including 2 ovigerous females from sample 10–7A; USNM 135756, 2 specimens from sample 10–7B; USNM 135758, 1 specimen from sample 10–16A; USNM 135759, 12 specimens from sample 10–19M; USNM 135760, 1 specimen from sample 10–36A; USNM 151165, 1 adult male from sample 10–1N; USNM 151166, 6 specimens from sample 10–1N; USNM 151167, 2 adult males from sample 10–5B; USNM 151168, 6 specimens from sample 10–5B; USNM 151169, 1 juvenile from sample 10–6B; USNM 151170, 2 specimens from sample 10–5M, USNM 151171, 1 female from sample 10–7M; USNM 151172, 1 specimen from sample 10–10B; USNM 151173, 1 adult male from sample 10–10M; USNM 151174, 2 juveniles from sample 10–16C; USNM 151175, 1 adult male from sample 10–19C; USNM 151176, 1 juvenile from sample 10–20C; USNM 151177, 1 specimen from sample 10–24A; USNM 151178, 1 female from sample 10–24C; USNM 151179, 1 female from sample 10–24C; USNM 151570, 1 female from sample 10–24M; USNM 151571, 1 adult male from sample 10–24M; USNM 151572, 1 juvenile from sample 10–28N; USNM 151573, 1 juvenile from sample 10–31A; USNM 151574, 1 specimen from sample 10–34C; USNM 151575, 1 specimen from sample 10–35A; USNM 151576, 1 adult male from sample 10–35A; USNM 151577, 1 specimen from sample 10–38N; USNM 151578, 2 females and 1 juvenile from sample 10–38N; USNM 135749, 2 females including 1 ovigerous from sample 7–15N; USNM 135750, 1 ovigerous female from sample 7–19N; USNM 151928, 2 specimens from sample 1–4B; USNM 151929, 1 specimen from sample 1–9A; USNM 151930, 1 specimen from sample 1–11A; USNM 151931, 1 ovigerous female from sample 1–15A; USNM 151932, 2 specimens from sample 1–15M; USNM 151933, 1 ovigerous female from sample 1–16A; USNM 151934, 3 specimens from sample 1–16B; USNM 151935, 3 specimens from sample 1–16C; USNM 151936, 2 specimens from sample 1–18C; USNM 151937, 1 specimen from sample 1–18B; USNM 151938, 1 specimen from sample 1–18M; USNM 151939, 2 specimens from sample 1–19A; USNM 151940, 3 specimens from sample 1–31N.

SUPPLEMENTARY DESCRIPTION OF ADULT.—Surface of carapace smooth (Figure 2*a*), brown except for clear oval area in vicinity of lateral eye; faint crescents that may be edges of ovals or polygons visible on some specimens (Figure 2*b*); small open pores (Figure 2*c*) scattered over valve surface (see arrows in Figure 2*b*).

Shell structure (Figure 2*d*): Formed of 3 layers: outer thin layer granular; middle layer less well laminated than inner layer, which makes up about half of shell. No differences were observed between shell structure in clear part in vicinity of lateral eye and surrounding brown part.

Infold: Posterior list with minute pores or processes (Figure 2*e,f*). Rostrum with bare bristles forming row along list dorsal to incisur; 1 stout bristle present posterior to bare bristles (Figure 3*a,b*); 1 slender bristle present posterior and ventral to stout bristle and near incisur (Figure 3*a–c*) 2 bare bristles near inner end of incisur (Figure 3*d*).

Lamellar prolongation of selvage: Prolongation along lower margin of incisur with perpendicular ridges forming serrated outer edge; prolongation along anterior margin of rostrum with smooth inner surface and outer edge (Figure 3*a,d*); prolongation on lower margin of incisur and on anteroventral margin ventral to incisur with ridges on inner side forming serrate outer edge (Figure 3*d,e*), and with smooth outer side (Figure 3*f*) (gives appearance of bristles connected by webbing).

First antenna of adult male: In natural position, pointing anteriorly and then ventrally (Figure 6*a*); b-bristle with short proximal branch containing disc (Figure 6*a,b*) and 2 filaments with smaller discs forming row (Figure 6*d–f*); edge of small discs beaded (Figure 6*f*); short filaments on long bristles of 7th and 8th joints with process at tip (Figure 6*c*).

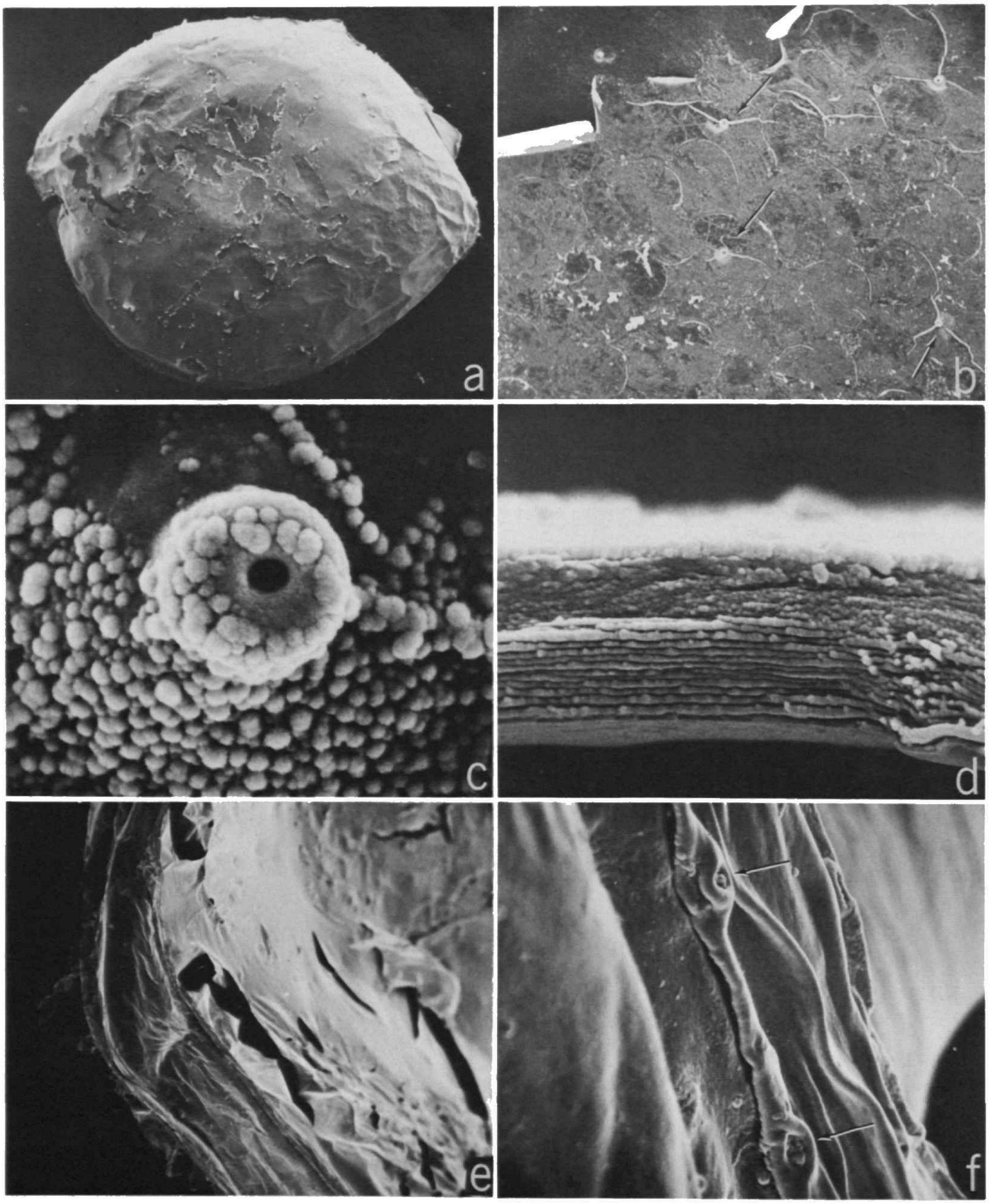

FIGURE 2.—*Macrocypridina castanea*, USNM 151167B, adult male, length 7.0 mm: *a*, left valve, outside view, anterior to left, × 17; *b*, surface near middle of shell shown in "a" in vicinity of adductor muscle scars (arrows point to pores), × 550; *c*, pore shown in "b," × 13,650; *d*, cross section of carapace in vicinity of lateral eye, outer surface of shell toward top, × 5350; *e*, posterior of left valve, inside view, × 120; *f*, detail of "e" showing small processes on posterior list (arrows) × 2370. (Photos reduced for publication to 75 percent.)

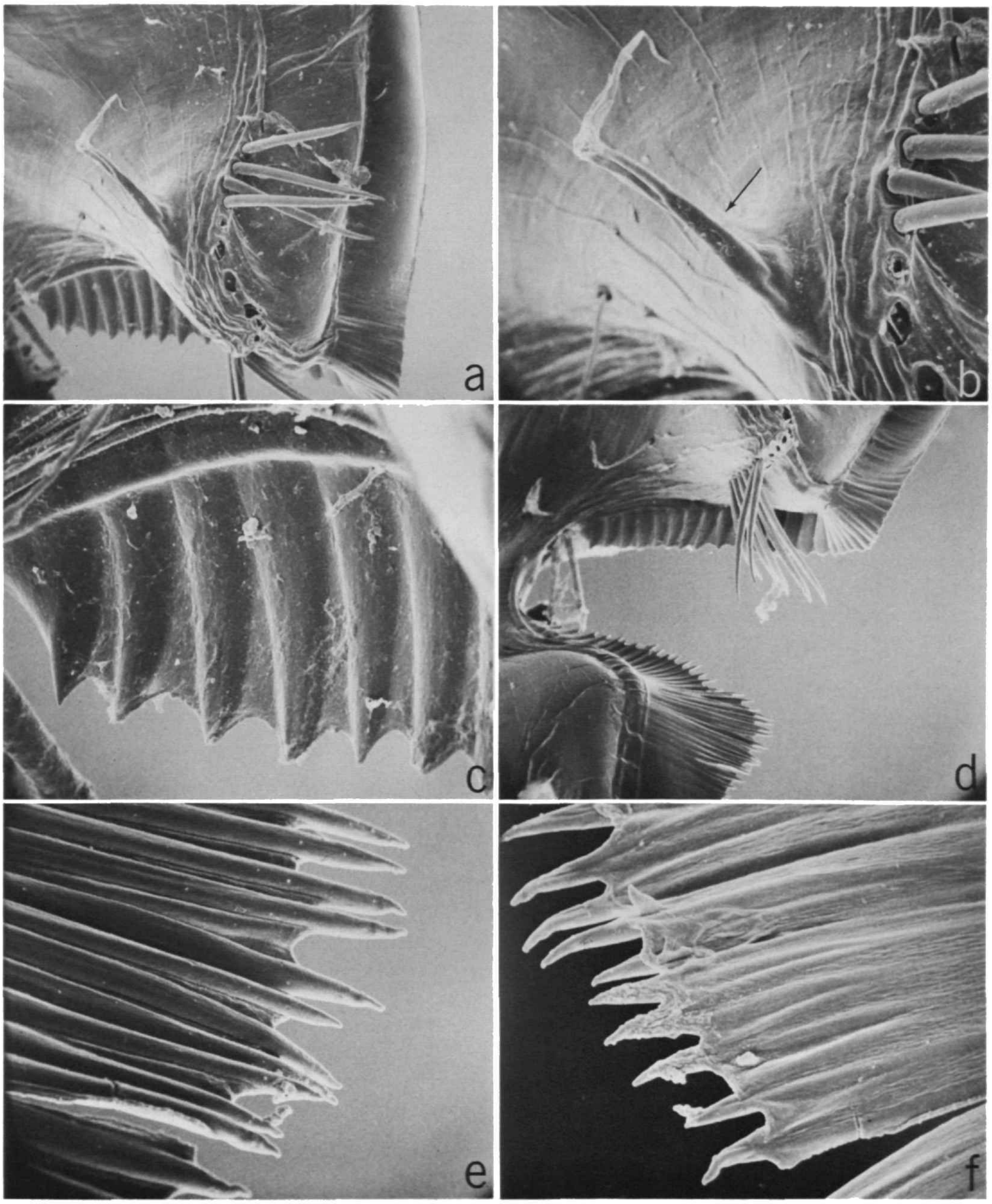

FIGURE 3.—*Macrocypridina castanea*, USNM 151167B, adult male, length 7.0 mm: *a*, incisur and bristles of rostrum, medial view, × 190; *b*, detail of "a" showing stout bristle of rostrum (arrow), × 460; *c*, lamellar prolongation of selvage along upper margin of incisur, from "a," × 900; *d*, incisur and bristles, medial view, × 190; *e*, lamellar prolongation of selvage below incisur, from "d," medial view, × 1135; *f*, outside view of lamellar prolongation of selvage shown in "e", × 1135. (Photos reduced for publication to 74 percent.)

Second antenna of adult male: Protopodite massive (Figure 7*a*); basal spines of exopodial joints small, absent on 9th joint (Figure 7*c*); distal margins of exopodial joints without spines (Figure 7*c*).

Mandible of adult male: 2nd endopodial joint with numerous medial spines (Figure 7*b*); some of these with fine marginal hairs proximally and longer spines distally, and with triaenid tip (Figure 7*d*).

Sixth limb of adult male: Limb small with posterior edge seeming to conform to anterior edge of copulatory organ (Figure 7*a,e*).

Seventh limb (Figures 4,5) *of A–1 female?:* Ends of bells oblique to stem and with long fringes (Figure 5*e*); fringe on tip of bristles slightly shorter than those on bells (Figure 4*e*); bristles proximal to bells with scattered spines similar to those forming fringe at tip of bristle (Figure 4*c*). Comb consisting of pointed teeth in middle part and flat-tipped teeth on each end (Figure 5*b–f*); flat-tipped teeth with rods along outer side, the middle of these bending into, and may be attached to, end of flat-tipped teeth (Figure 5*d–f*); flat-tipped teeth with pore at tip (Figure 5*e–f*). Antler-like processes opposite comb (Figures 4*b,d*;5*b*) consisting of a central toothlike process with alar projections on either side near its base; margin of alar projections with 4–7 finger-like digitations (Figure 4*b,d*). Simple conelike peg present between comb and antler-like process (Figures 4*b,d;* 5*b,c*).

Furca of adult male: Claws with scattered short spines on anterior margin and lateral and medial row of teeth along dorsal margin (Figure 7*a,f*).

Upper lip of adult male (Figures 8–11): In natural position, main glandular field oriented anteriorly (Figure 9*a*); main glandular field with about 70 glandular openings (Figure 9*b,d*); a pair of glandular processes present on each side ventral and posterior to main glandular field (Figures 9*b,d,f;* 11*a*); proximal of these processes conelike with single terminal glandular opening (Figures 10*b,d,e;* 11*a*); distal process with 3–4 cones; posterior of these with 2 glandular openings; anterior 1–2 cones with single glandular openings (Figure 11*b,d–f*); small lateral field with about 44 glandular openings present posterior and proximal to main field; glandular openings on paired glandular processes (Figures 9*f;* 10*f;* 11*a,b*); similar to those of main field (Figures 10*f;* 11*d,e*) but larger than those in lateral fields (Figures 9*c;* 10*d,e;* 11*c*); ventral end of upper lip, when in natural position, bearing shallow flat-bottomed groove (Figures 9*b,d;* 10*a,b*); groove terminating abruptly before reaching mouth (Figure 10*b*); short spines forming rows present between end of groove and mouth, spines point toward mouth (Figure 10*c*). (the lateral glandular fields and ventral flat-bottomed groove have not been reported previously.)

Male copulatory organ (Figures 7*a–e;* 12–14): When viewed laterally and in place on animal, intricate structure of copulatory organ not visible (Figure 7*a,e*). 2 lobes, anterior to base of the organ each with 2 spinous terminal bristles, are considered brush-organs (see Poulsen, 1962:126); copulatory organ with anterior proximal lobe with about 5 tubelike bristles, with terminal pore on distal outer corner and clawlike terminal process; clawlike process with small open pores and minute teeth proximally; pustules and small teeth form rows on terminal end of proximal lobe near clawlike process; 2-jointed main lobe present posterior to proximal lobe; 2nd joint formed by finger-like terminal process; tip of finger-like process with few minute pustules and many open pores; distal inner corner of 1st joint of main lobe near base of finger-like process with anterior triangular process (see arrow in Figure 12*b*); distal inner corner of 1st joint of main lobe with about 13 posterior bristles.

Poulsen (1962:125, Figure 63*a,c–g*) stated that the inner lobe had its base posterior to the main lobe, not anterior as illustrated herein (Figure 13*b*). He described about 10 proximal bristles on the inner edge of the main lobe, and 5 bare bristles on the anterior side of the distal end of the 1st joint of the main lobe near the triangular process. These do not appear in our photographs; however, about 5 bare tubelike bristles are present in our photographs on the anterior side of the inner distal corner of the proximal lobe, and about 13 bristles appear on the distal end of the 1st joint of the main lobe on the posterior side. These were not mentioned by Poulsen.

Gigantocypris muelleri **Skogsberg, 1920**

FIGURES 15–20

Gigantocypris agassizi [part].—Müller, 1906:135–136.
Gigantocypris pellucida.—Fowler, 1909:257,296.—Scott, 1912:5.

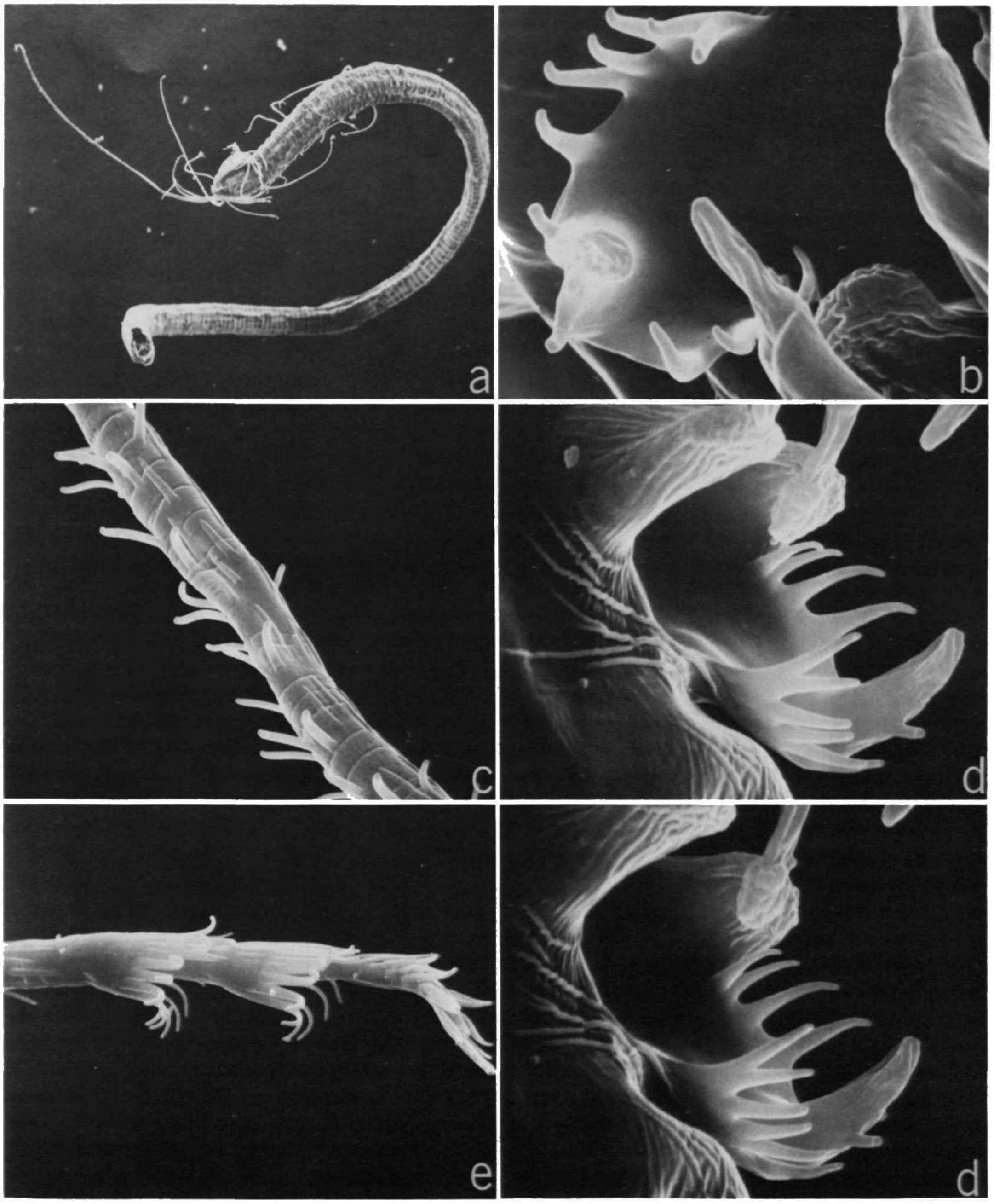

FIGURE 4.—*Macrocypridina castanea*, USNM 151578B, A-1 female?, 7th limb: *a*, complete limb, × 50; *b*, end view of end of limb showing terminal antler-like process, × 750; *c*, middle part of marginal bristle showing spines, × 2700; *d*, stereo pair of antler-like terminal process, lateral view (to be viewed from right), × 5500; *e*, tip of marginal bristle, × 2200. (Photos reduced for publication to 79 percent.)

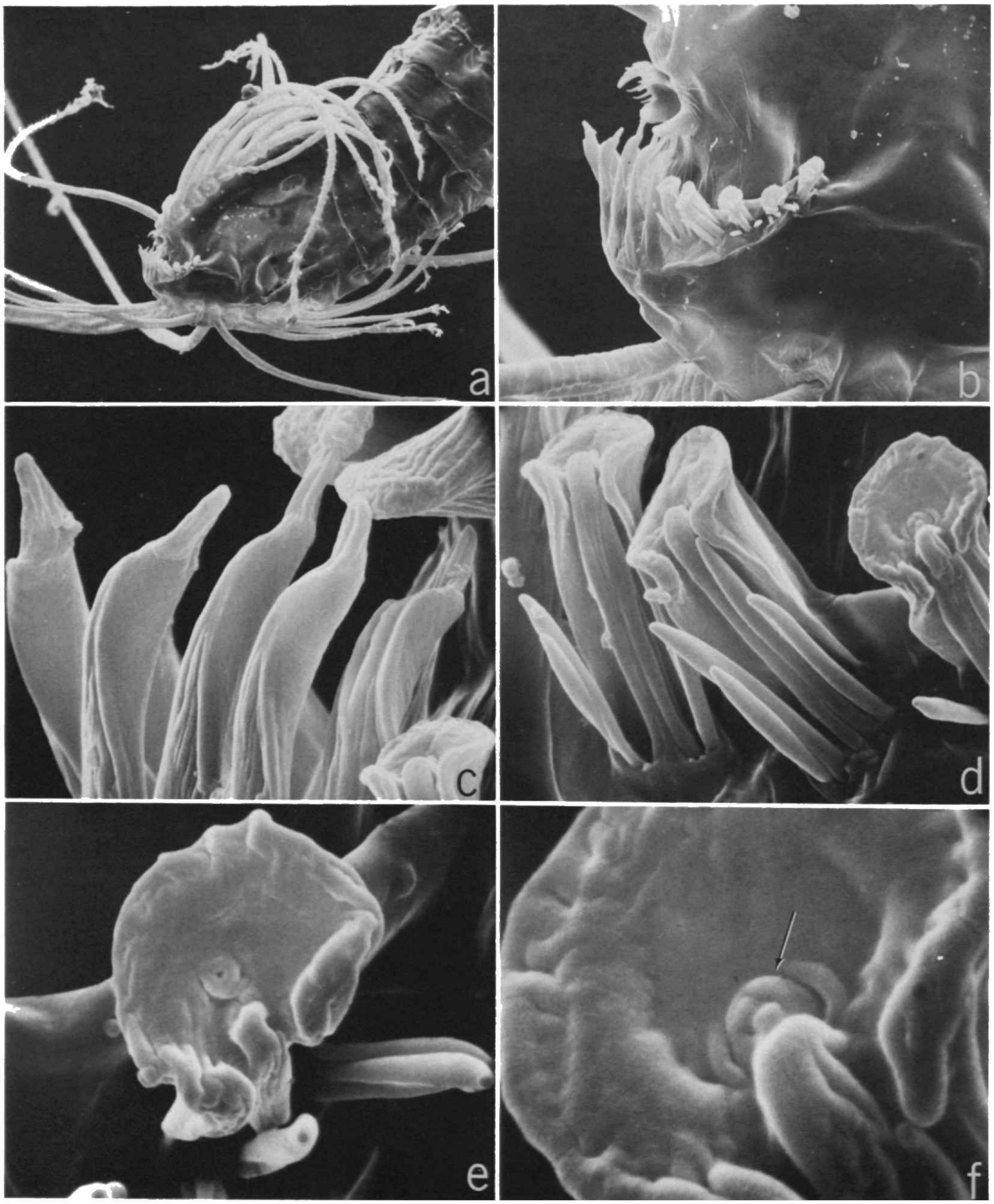

FIGURE 5.—*Macrocypridina castanea*, USNM 151578B, A-1 female?, 7th limb (continued): *a*, terminal end of limb, from Figure 4*a*, × 250; *b*, comb and processes, from "a," × 1025; *c*, distal comb teeth, from "b," × 5500; *d*, flat-tipped, proximal comb teeth, from "b," × 5500; *e*, tip of proximal comb tooth, not terminal pore (2nd from right comb tooth shown in "b," × 1100; *f*, tip of right proximal comb tooth in "d" showing indication of terminal pore (arrow), × 2200. (Photos reduced for publication to 74 percent.)

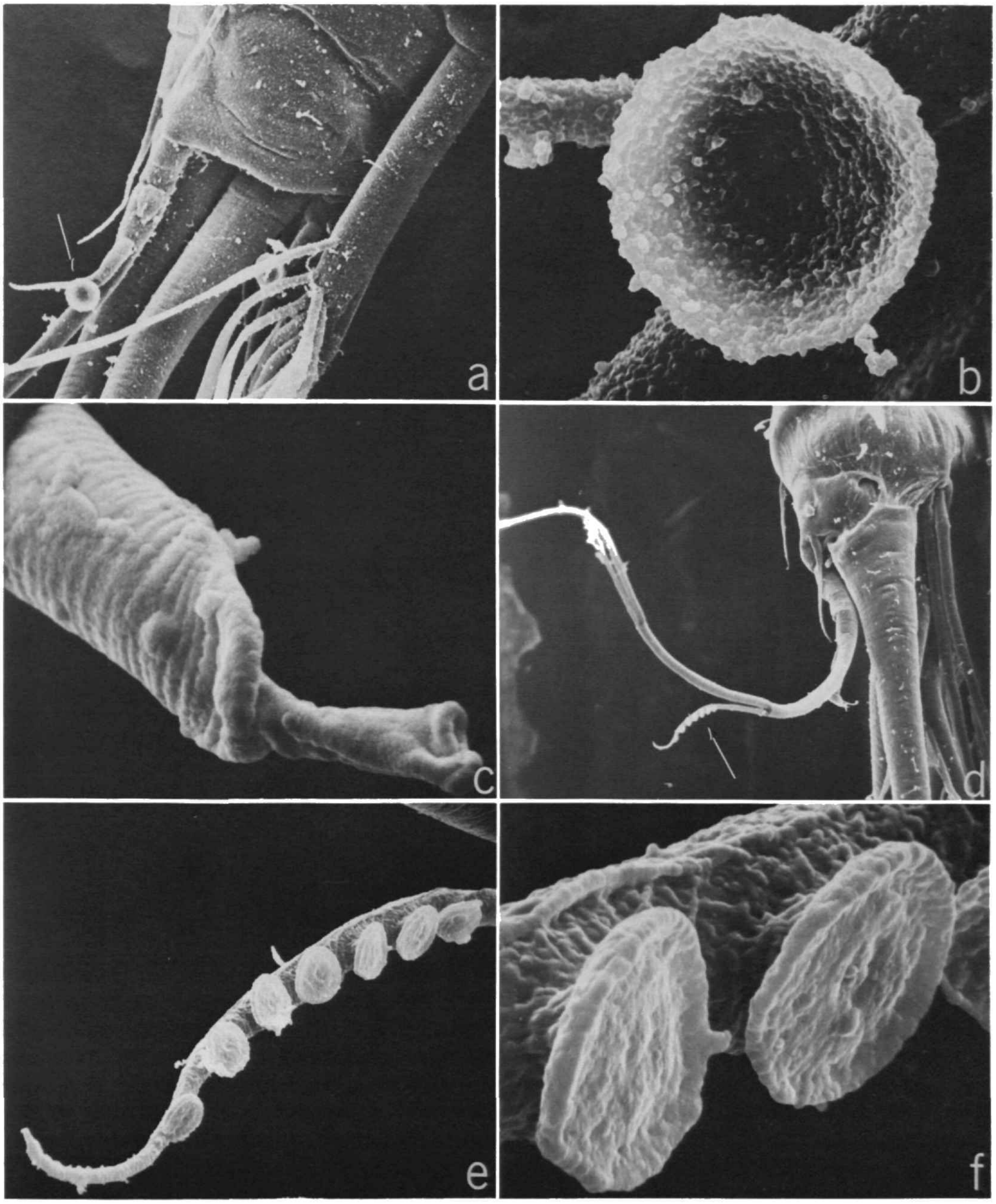

FIGURE 6.—*Macrocypridina castanea*, USNM 151177, adult male, right 1st antenna: *a*, tip of antenna, medial view, from Figure 9*a*, × 200; *b*, detail of concave disc on b-bristle, from "a" (arrow in "a"), × 2200; *c*, tip of one of the short sensorial filaments on a long bristle, × 12,000. USNM 151576, adult male, left 1st antenna: *d*, tip of antenna, lateral view, × 180; *e*, proximal filament on b-bristle shown in "d" (arrow in "d"), × 1250; *f*, detail of discs shown in "e," note beaded margin of discs, × 2500. (Photos reduced for publication to 74 percent.)

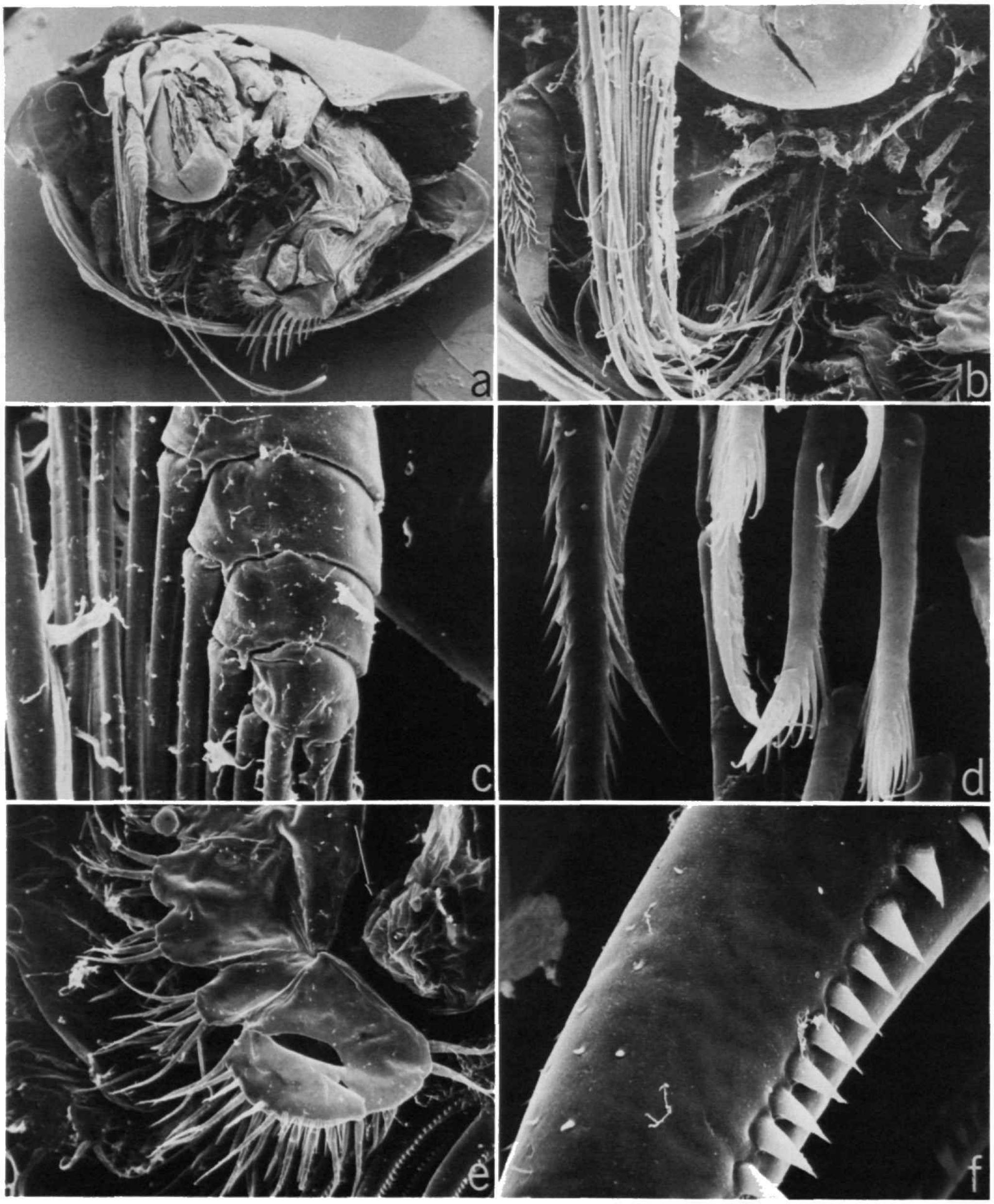

FIGURE 7.—*Macrocypridina castanea*, USNM 151576, adult male, length 6.4 mm., specimen with left mandible, left maxilla, and most of left valve removed: *a*, whole specimen, × 20; *b*, detail of "a" showing bristles of left 1st and 2nd antennae entering mouth (arrow) 1 × 60; *c*, distal joints of exopodite of left 2nd antenna, note small basal spines, from "a," lateral view, × 250; *d*, detail of cleaning bristles of 2nd endopodial joint of right mandible, from "b," medial view, × 1250; *e*, left 6th limb and anterior part of copulatory organ (arrow), from "a," lateral view, × 115; *f*, teeth on 4th furcal claw, from "a," lateral view × 1150. (Photos reduced for publication to 72.5 percent.)

Gigantocypris Mülleri.—Skogsberg, 1920:202–219, figs. 26–29. *Gigantocypris mülleri*.—Cannon, 1940:319–321, figs. 1,2a.—Poulsen, 1962:57–84, figs. 26–41.—Tibbs, 1965:481.

MATERIAL.—USNM 151581, 1 adult female from sample 10–10b; USNM 151582, 1 instar IV female from sample 10–24C; USNM 151983, 1 instar IV female from sample 9–21N.

SUPPLEMENTARY DESCRIPTION OF ADULT FEMALE.—Size: USNM 151581, length 16.4 mm, height 15.1 mm.

Second antenna: 1st endopodial joint with 5 short bristles, 2nd joint with 1 short subterminal bristle, 3rd joint with 1 long terminal bristle.

Seventh limb: Each limb with 232 bristles, 113–119 on each side; the number of bells on each bristle ranges from 5 to 10; 52 teeth in comb.

Furca: Each lamella with 11 claws.

Genitalia: Well developed.

SUPPLEMENTARY DESCRIPTION OF INSTAR IV FEMALE.—Surface of carapace smooth, but with faint polygons visible at high magnification (× 150) (Figure 15*a*); noded pores with bristles very sparse on valve surface (Figure 15*b–d*); shell in cross section laminated (Figure 15*f*); numerous struts present between shell and vestment (Figure 15*e*).

Size: USNM 151582, length 9.8 mm, height 8.9 mm; USNM 151983, length 9.9 mm, height 9.0 mm.

Second antenna: 1st endopodial joint with three short bristles, 2nd joint with one short subterminal bristle, 3rd joint with one long terminal bristle.

Seventh limb (Figures 16, 17): Each limb with 79–90 bristles, 37–48 on each side; bells of bristles with fringed distal margin forming oblique angle with stem (Figure 16*b*); oblique tip of bristle with fringe shorter than that of bells (Figure 16*e,f*); surface of stem of each bell formed of about 25 longitudinal rods (Figure 16*c,d*), each rod about one-third diameter of fringe of bells; tip of limb with comb and single peg opposite comb (Figure 17*a–c*); only 7 teeth in comb of juvenile specimen; teeth with squarish tips and marginal spines (Figure 17*b*); tips of teeth with minute pore (Figure 17*c–d*); smooth peg situated close to comb (Figure 17*c*).

Furca: Each lamella with 9 claws.

Lips (Figures 18, 19, 20*a–c*): In natural position, main glandular field oriented anteriorly (Figure 18*a*); main field with about 175 closely packed glandular openings (Figure 18*d*); 2 lateral fields present (Figure 18*a–c*); upper (dorsal) lateral field with about 38 glandular openings; lower (ventral) lateral field adjacent to upper field, and with about 95 glandular openings; long hairs border anterior, ventral, and posterior margins of lower lateral field, and posterior border of upper lateral field (Figure 18*b,c*); glandular openings of main field similar in size to those of lateral fields, also similar in construction, all bear outer rim (Figures 19*c–f*; 20*a–c*); string of material emerging from glandular opening shown in Figure 19*d,e* may be debris, but bubble emerging from glandular opening in Figure 20*c* could be glandular discharge; ventral margin of upper lip with flat U-shaped surface bearing groups of short spines with tips oriented toward mouth (Figure 18*e,f*); surface of upper lip near mouth with densely spaced hairs forming rows (Figure 19*a*); tips of bristles oriented toward mouth; similar bristles also present on lower lip near mouth (Figure 19*b*).

Stomach wall: The stomach wall bears a papillate surface (microvilli?) (Figure 20*d–f*).

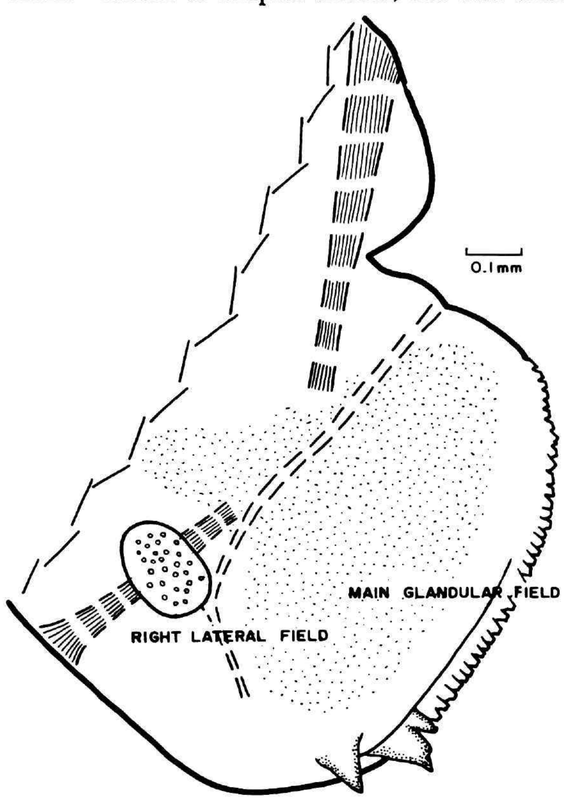

FIGURE 8.—*Macrocypridina castanea*, USNM 151177, adult male, upper lip: labeled diagram showing glandular fields and processes.

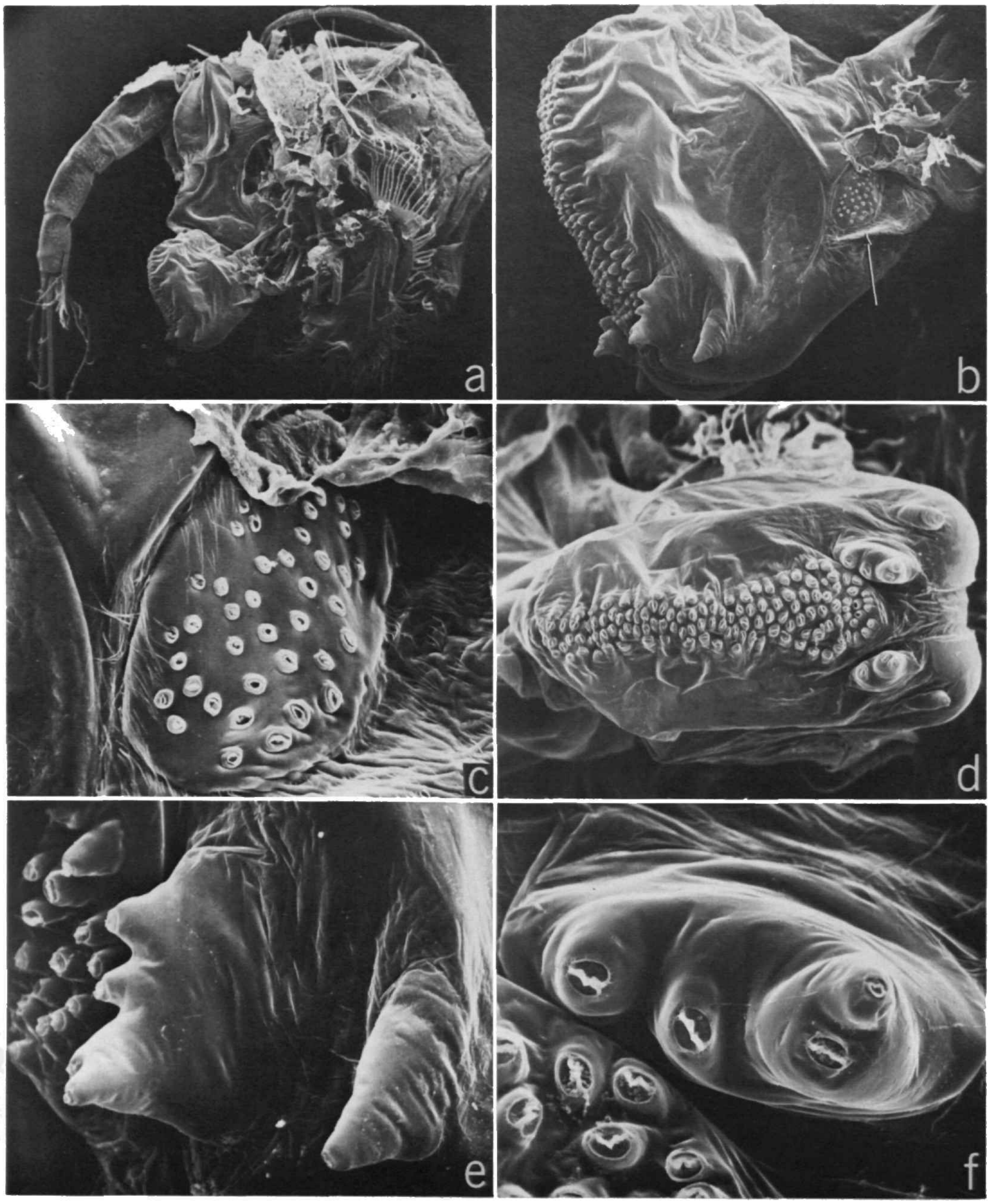

FIGURE 9.—*Macrocypridina castanea*, USNM 151177, adult male: *a*, Specimen with most appendages of left side removed to expose upper lip, × 25. Upper lip: *b*, lateral view, from "a," × 75; *c*, left lateral glandular field shown in "b" (arrow in "b"), × 300; *d*, anterior view of lip shown in "b," dorsal margin to left, × 91; *e*, left glandular processes, from "b," × 300; *f*, end view of left anterior glandular process, from "d," × 525. (Photos reduced for publication to 74.5 percent.)

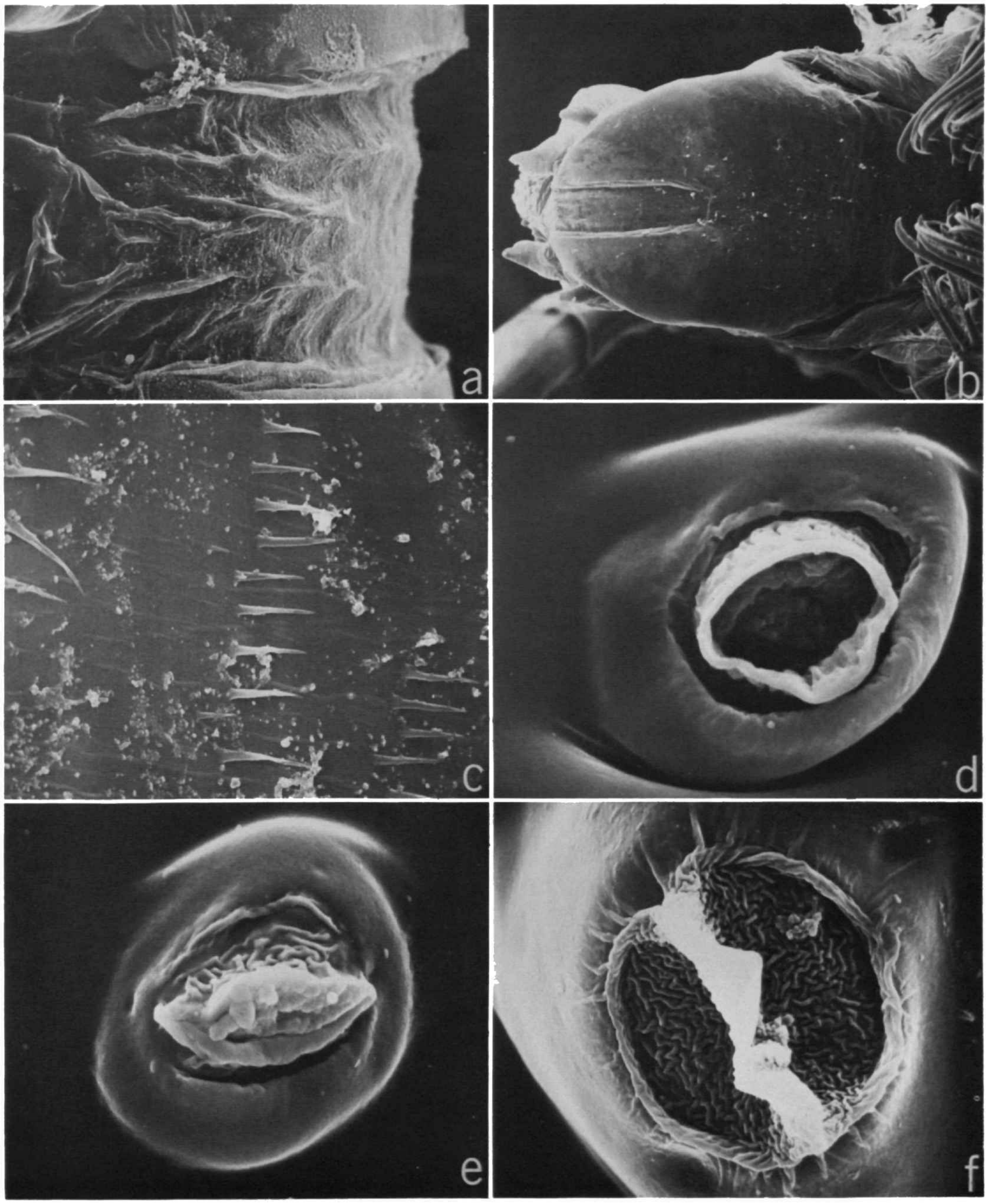

FIGURE 10.—*Macrocypridina castanea*, USNM 151177, adult male, upper lip: *a*, groove in posterior of lip, from Figure 9*d*, × 525; *b*, posteroventral view, mouth to right of photograph, × 91; *c*, spines on lip near mouth, from "b," × 1800; *d*, *e*, glandular openings from left lateral field shown in Figure 9*c*, × 6700; *f*, glandular opening from left anterior glandular process shown in Figure 9*f*. (Photos reduced for publication to 76 percent.)

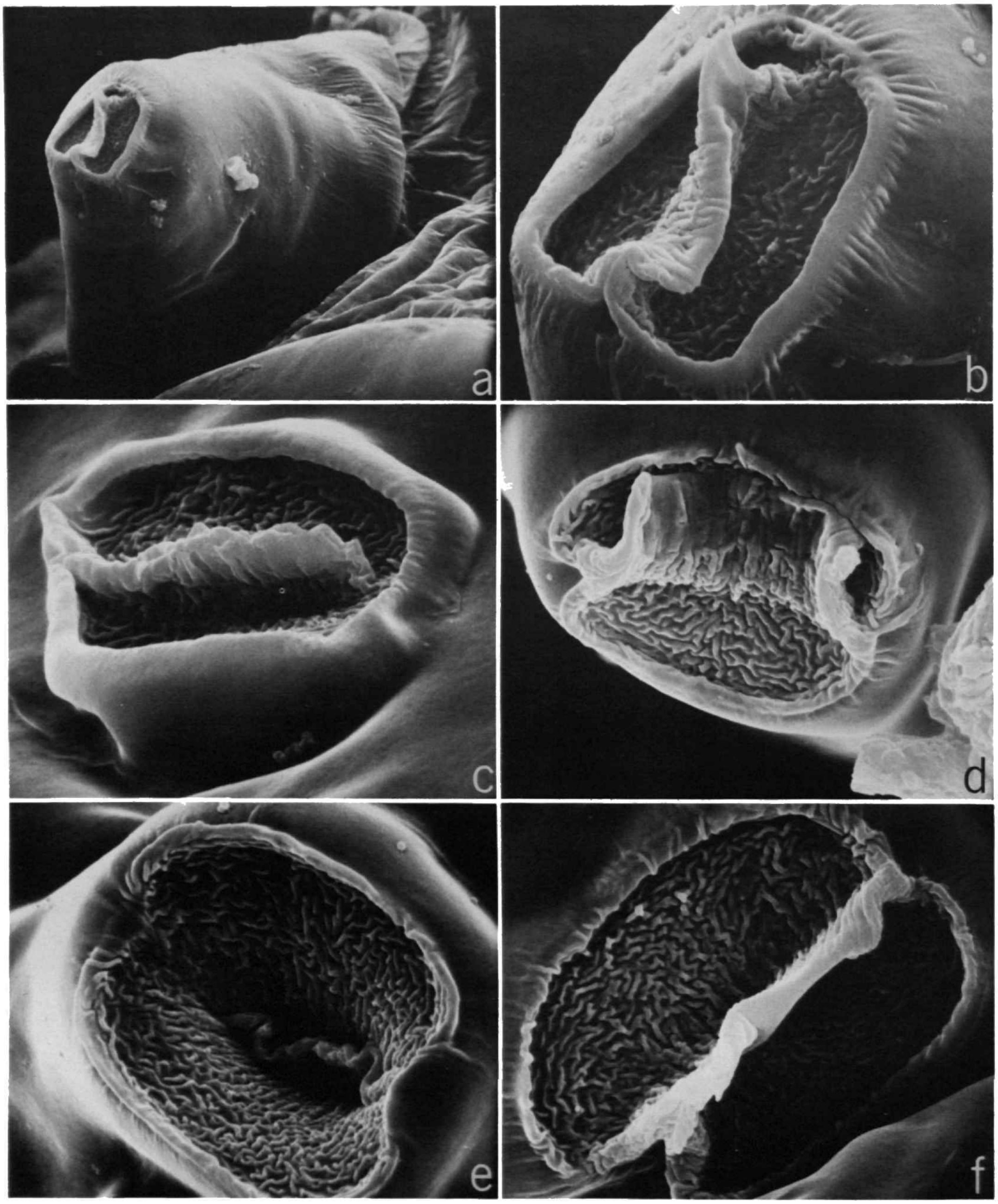

FIGURE 11.—*Macrocypridina castanea*, USNM 151175, adult male, upper lip: *a*, right posterior glandular process, × 1400; *b*, glandular opening in "a," × 5200; *c*, glandular opening from right lateral field, × 5200; *d*, *e*, glandular opening from main field, × 4000; *f*, glandular opening from left anterior glandular process, × 4000. (Photos reduced for publication to 76.5 percent.)

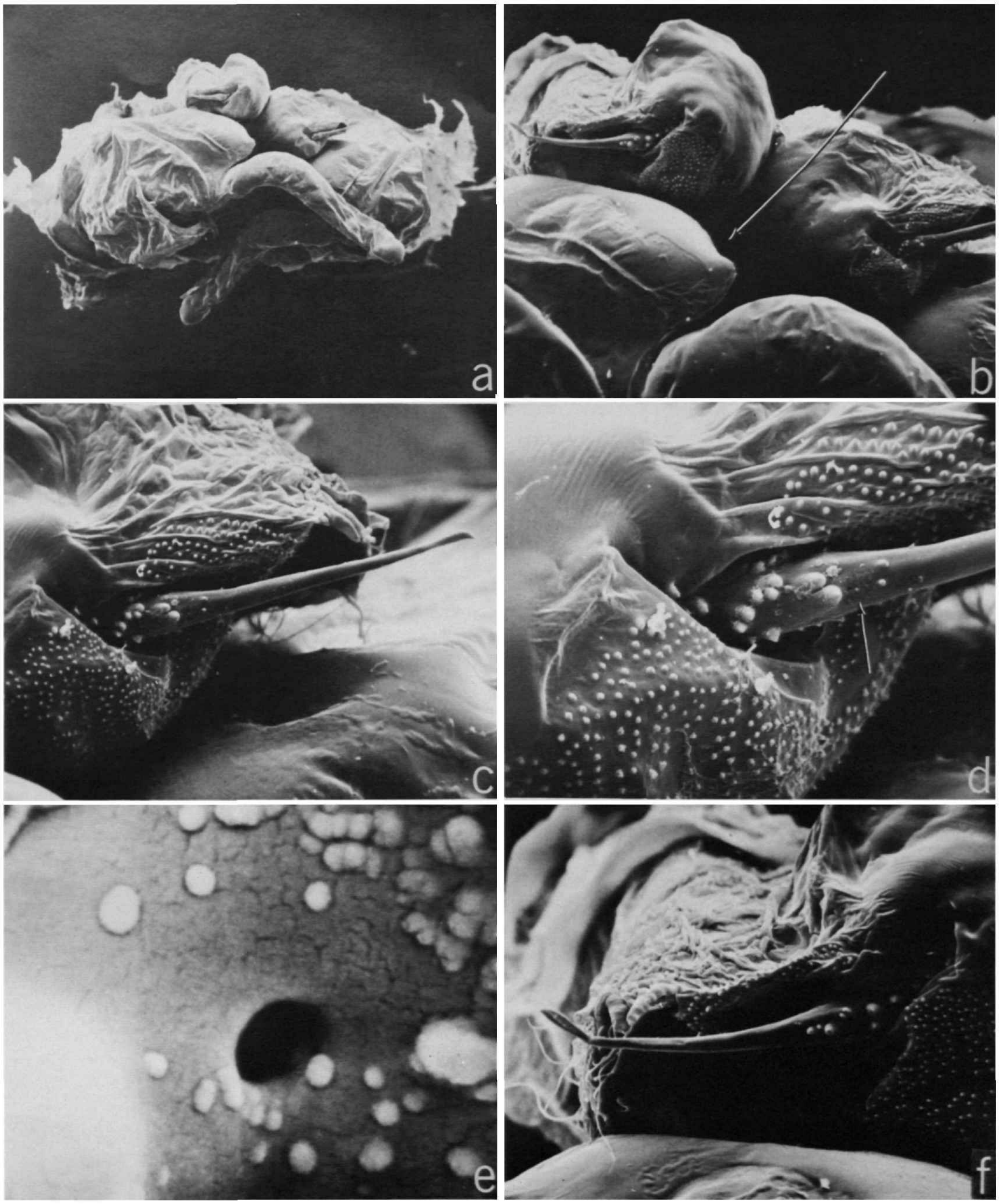

FIGURE 12.—*Macrocypridina castanea,* USNM 151176A, adult male, copulatory organ: *a,* ventral view with anterior toward top, × 90; *b,* detail of 2 upper lobes in "a," × 290; *c,* claw of right lobe in "c," × 725; *d,* base of claw in "c," × 1200; *e,* pore in claw shown in "d" (arrow in "d"), × 24,000; *f,* claw of left lobe in "b," × 725. (Photos reduced for publication to 77 percent.)

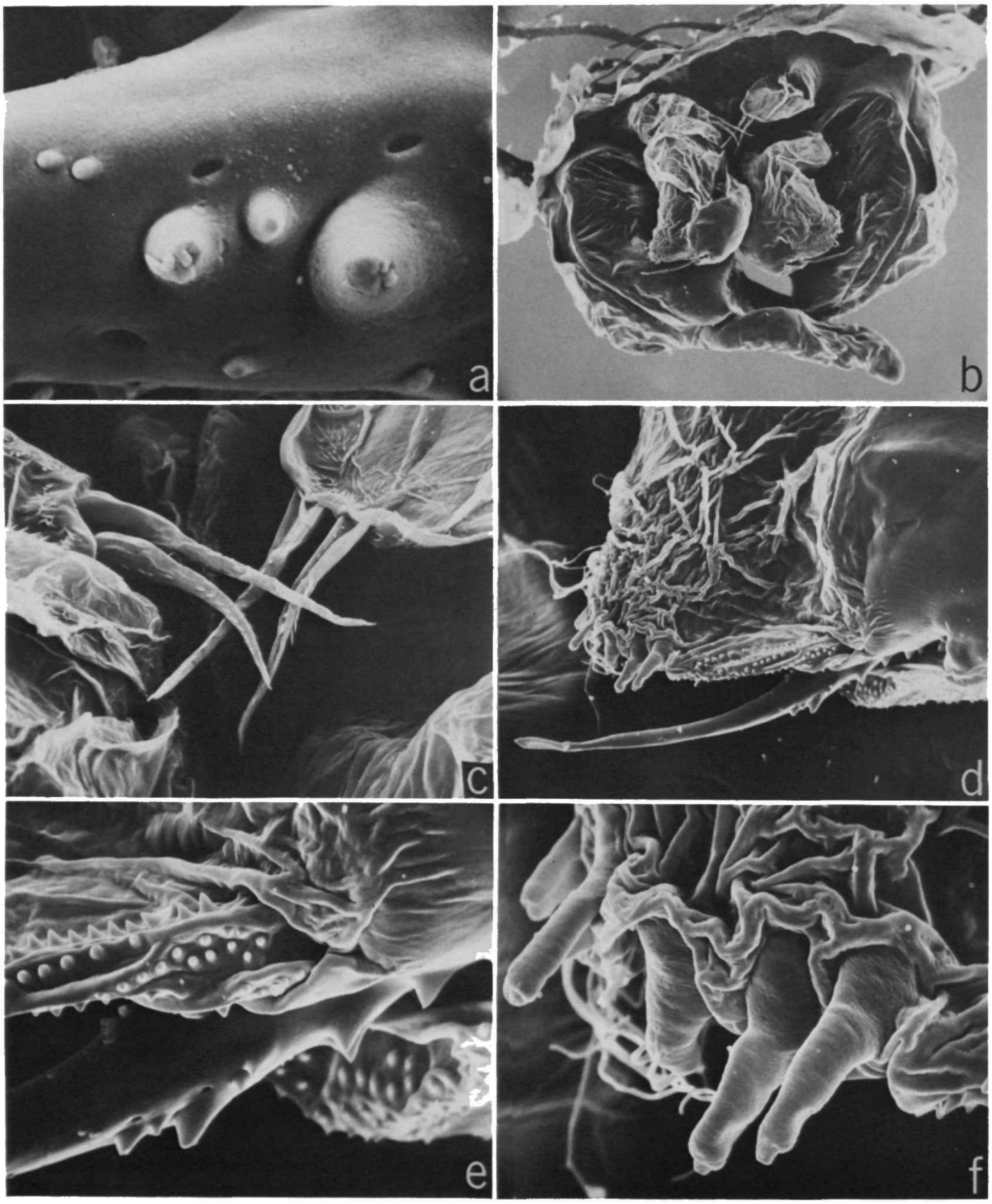

FIGURE 13.—*Macrocypridina castanea*, USNM 151176A, adult male, copulatory organ and brush organ: *a*, pores in claw shown in Figure 12*f*, × 7250; *b*, anterior view of copulatory organ, × 115; *c*, tips of brush organs, from "b," × 725; *d*, proximal lobe on left of "b," × 725; *e*, proximal part of claw in "d," × 2270; *f*, tube bristles on distal left corner of lobe in "d," × 2900. (Photos reduced for publication to 74 percent.)

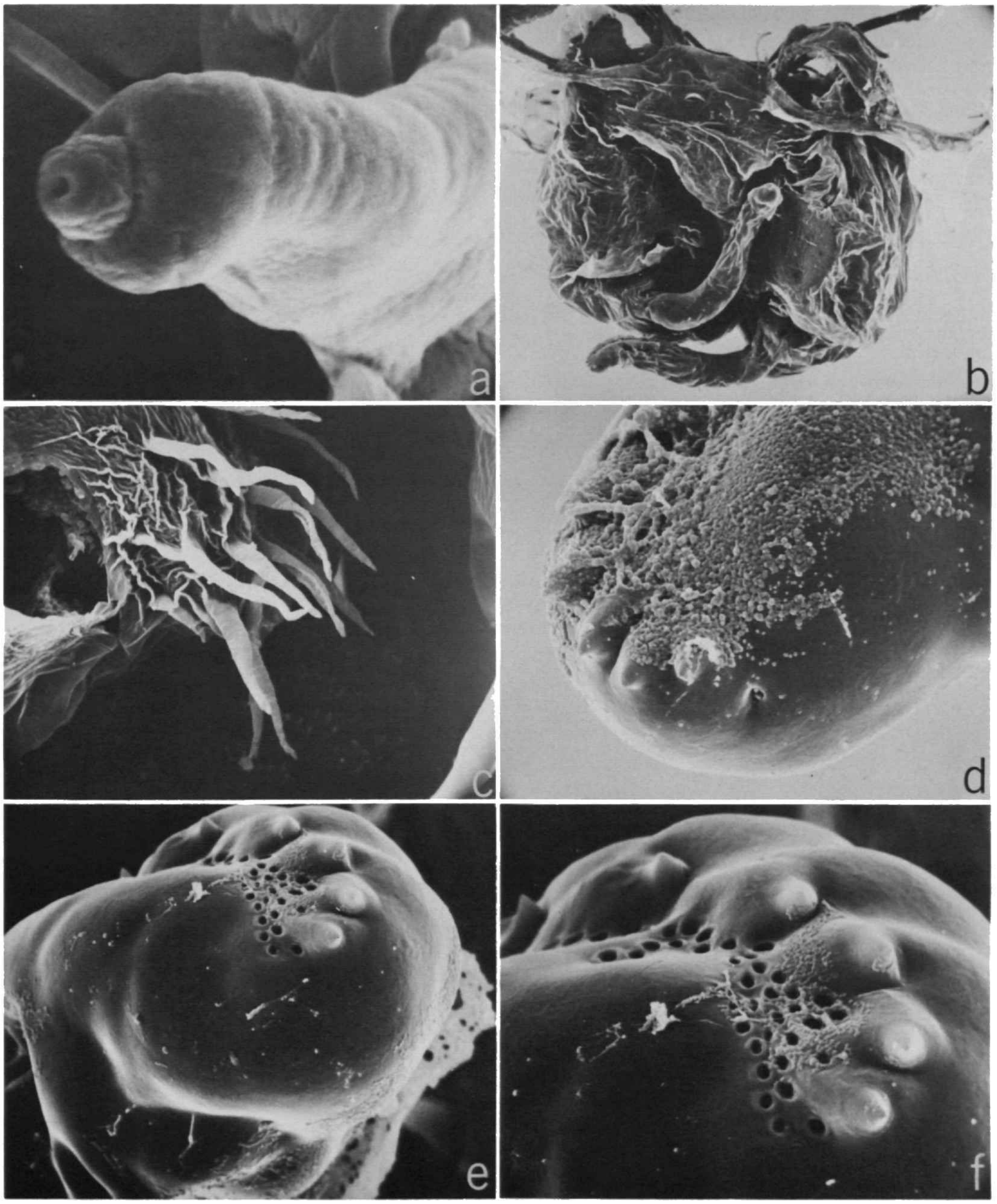

FIGURE 14.—*Macrocypridina castanea*, USNM 151176A, adult male, copulatory organ: *a*, tip of tube bristle in Figure 13*f* reoriented to show terminal pore, × 15,000; *b*, posterior view of copulatory organ, × 100; *c*, bristles on inner distal end of 1st joint of left distal lobe, from "b," × 860; *d*, tip of 2nd joint of right distal lobe in "b," × 1735; *e*, tip of 2nd joint of left distal lobe in "b," × 1435; *f*, detail of pores in "e," × 2250. (Photos reduced for publication to 74 percent.)

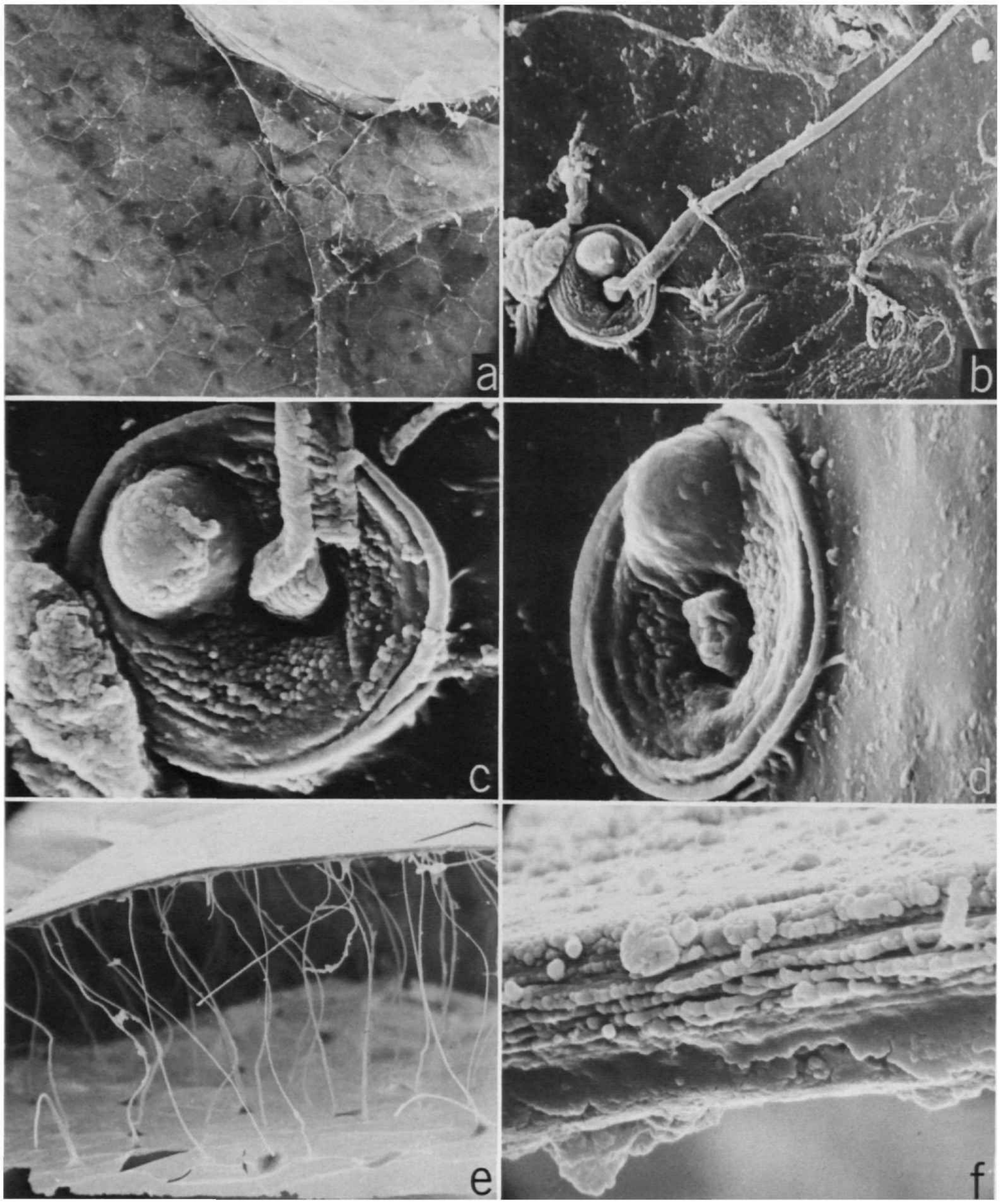

FIGURE 15.—*Gigantocypris muelleri*, USNM 151983, instar IV female carapace, length 9.9 mm: *a*, outer surface of shell, note faint reticulations (arcuate lines crossing photograph are artifacts caused by creases in shell), × 150; *b*, noded pore with bristle on outer surface of shell, × 2300; *c*, noded pore in "b," × 8000; *d*, noded pore with broken bristle, × 8000; *e*, cross section through shell (top) and vestment (bottom) showing numerous struts, × 250; *f*, section through shell showing laminations (outer surface of shell towards top; smoothness of inner layer probably caused by smearing during slicing process), × 7600. (Photos reduced for publication to 72 percent.)

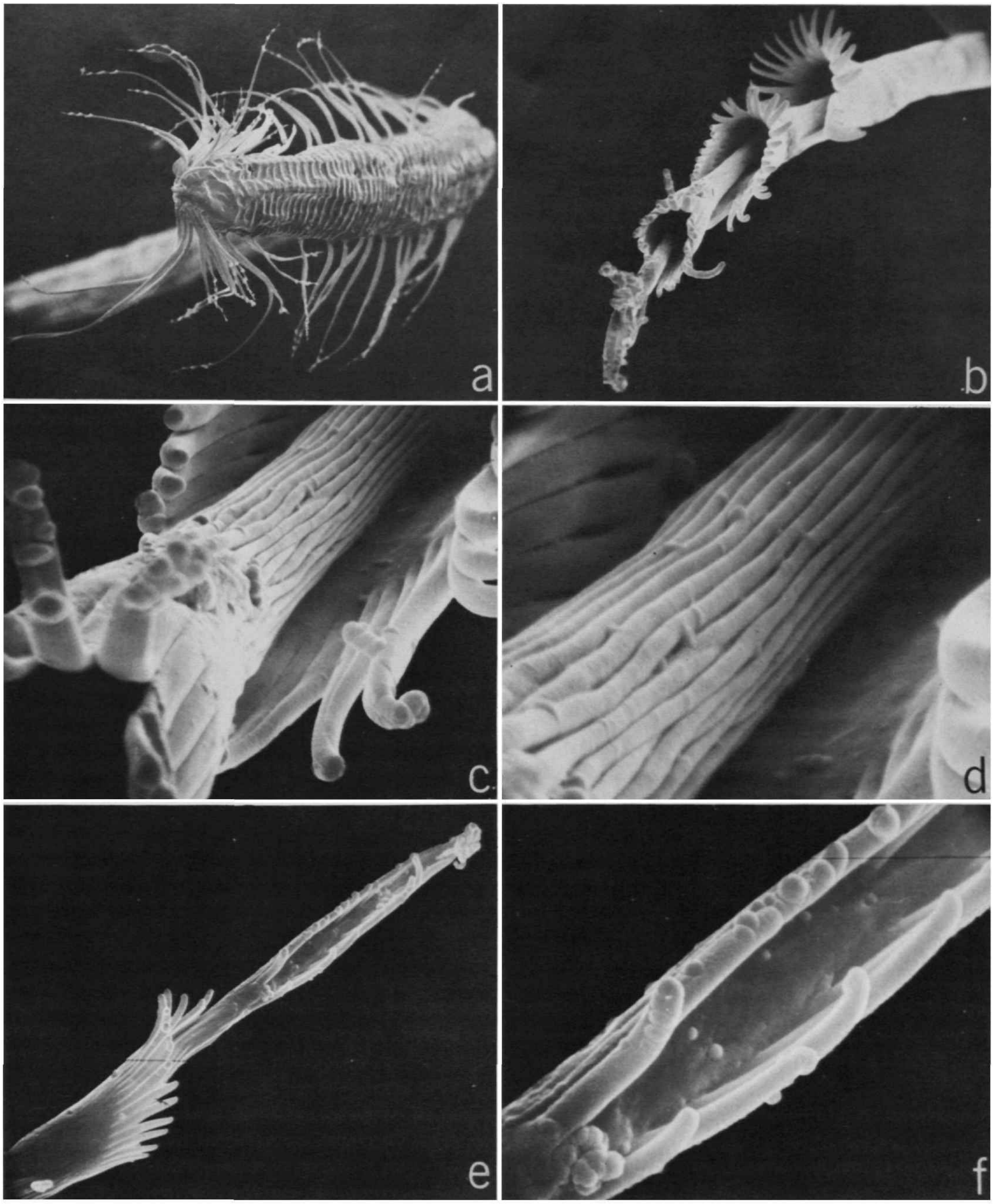

FIGURE 16.—*Gigantocypris muelleri*, USNM 151582, instar IV female 7th limb: *a*, complete limb, × 85; *b*, tip of marginal bristle, × 1800; *c*, detail of 3rd bell in "b," × 9100; *d*, detail of bell stem in "c," × 17,900; *e*, tip and end bell of a marginal bristle, × 1700; *f*, proximal part of tip in "e," × 10,500. (Photos reduced for publication to 77.5 percent.)

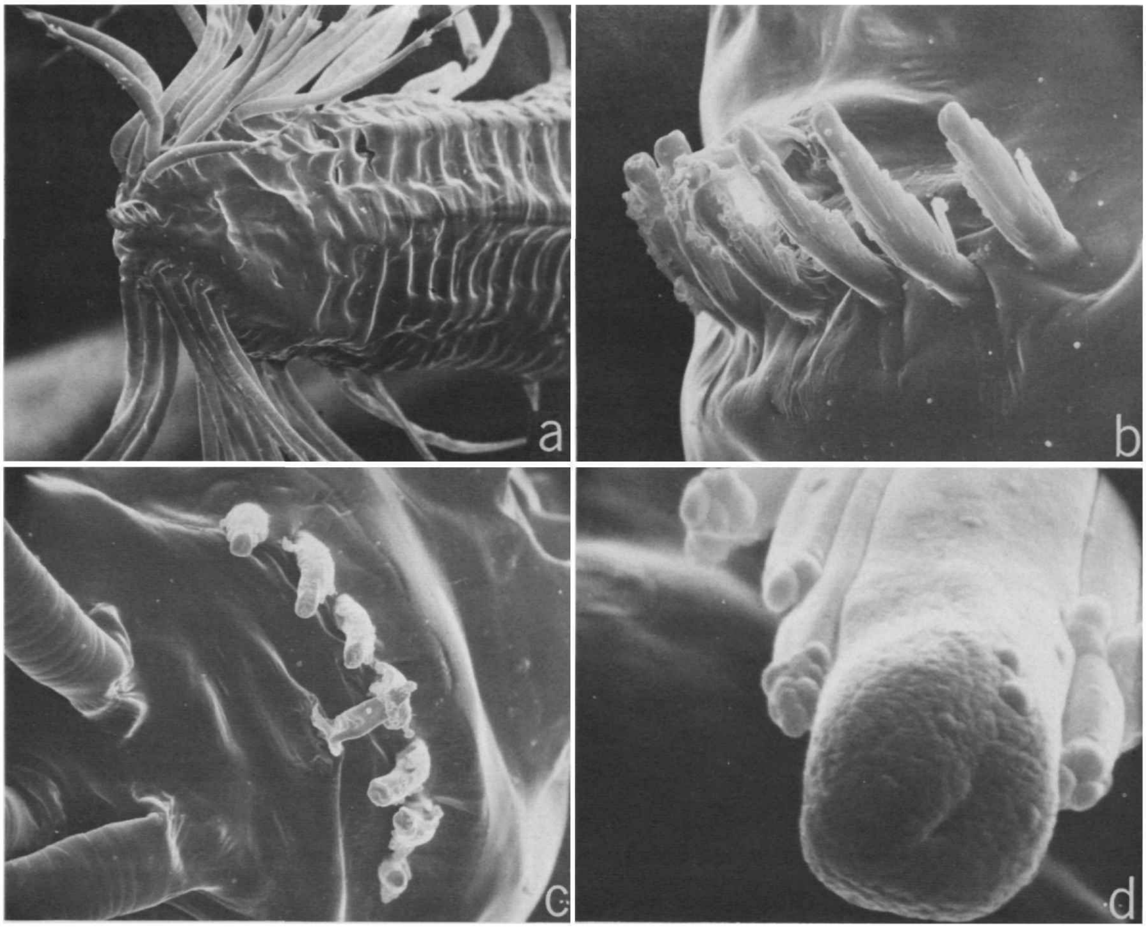

FIGURE 17.—*Gigantocypris muelleri*, USNM 151582, instar IV female 7th limb: *a*, tip of limb, from Figure 16*a*, × 240; *b*, terminal comb, from "a," × 2000; *c*, end view of comb and opposing peg, × 1450; *d*, tip of upper tooth in "c" showing terminal pore, × 16,500. (Photos reduced for publication to 81 percent.)

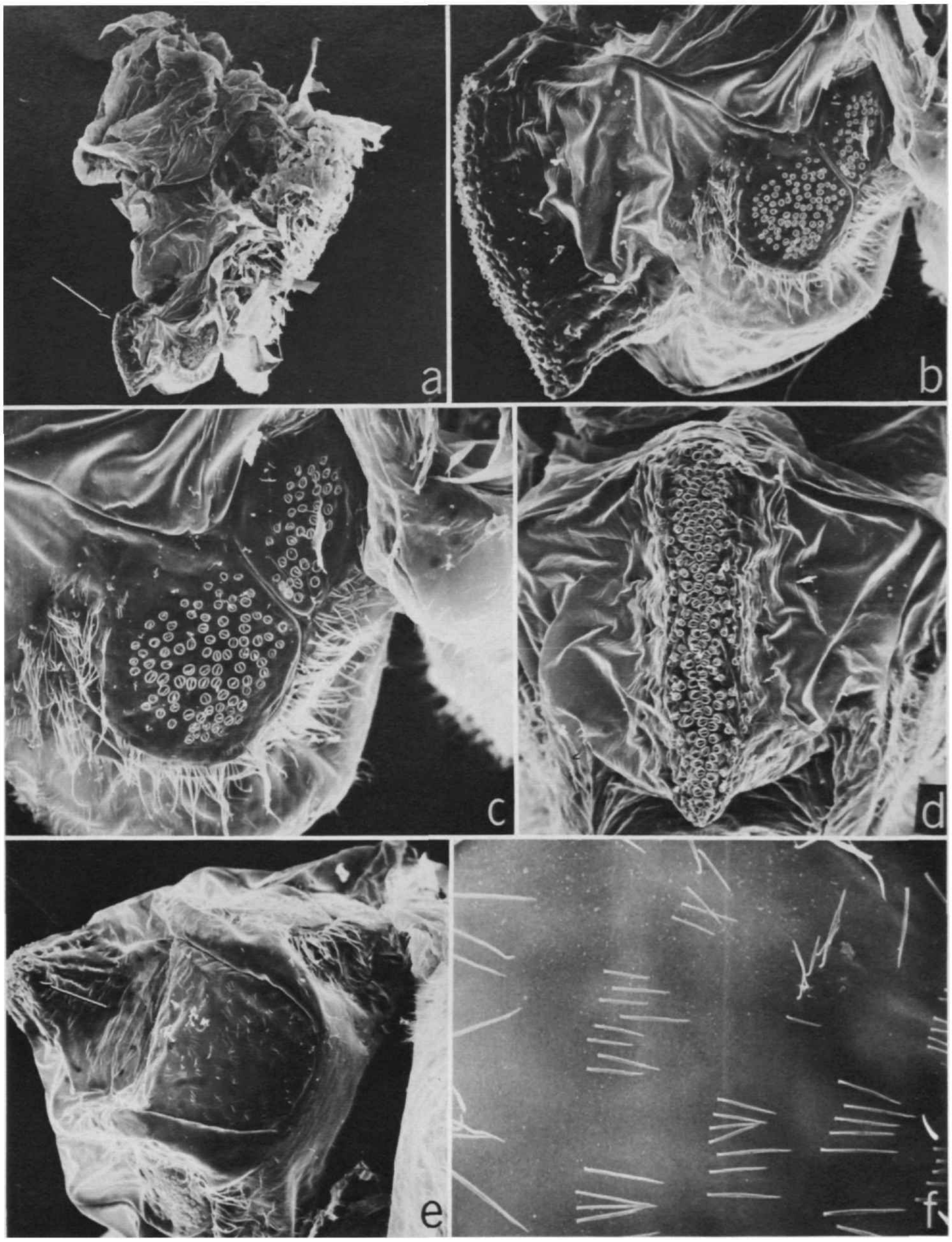

FIGURE 18.—*Gigantocypris muelleri*, USNM 151983, instar IV female lips: *a*, left lateral view of anterior half of body with appendages removed to show upper lip (arrow), the anterior half of the lower lip is to the right of the upper lip, × 22; *b*, upper lip in "a," × 91; *c*, left lateral glandular fields, from "b," × 160; *d*, anterior view of upper lip showing main glandular field, × 106; *e*, ventral view of upper lip (on left) and lower lip (on right), dark area between lips is mouth (arrow points toward anterior), × 80; *f*, spines on midventral U-shaped area of upper lip in "e," × 800. (Photos reduced for publication to 70 percent.)

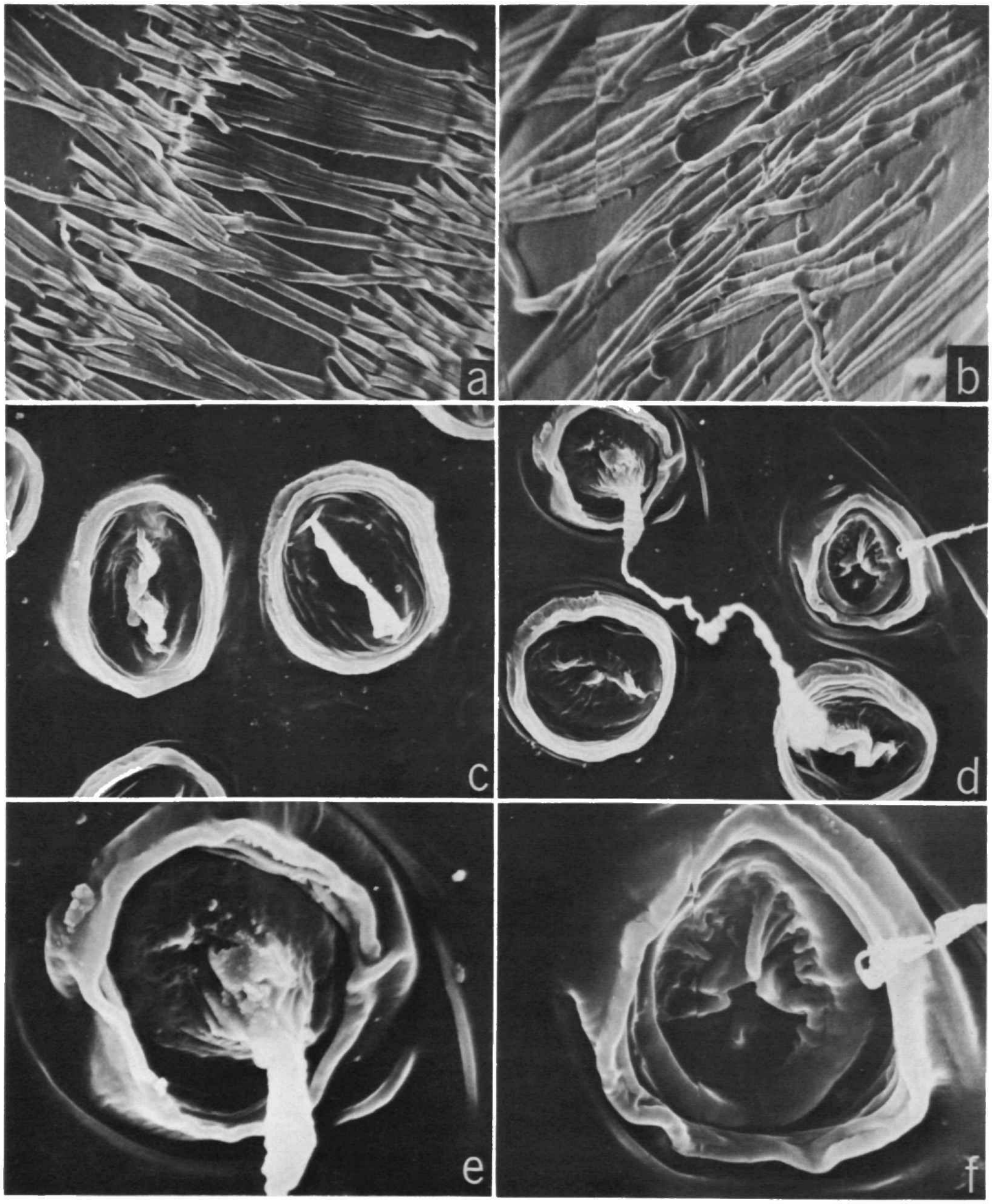

FIGURE 19.—*Gigantocypris muelleri*, USNM 151983, instar IV female lips: *a*, bristles on upper lip near mouth, from Figure 18*e*, mouth is to right, × 5600; *b*, bristles on lower lip near mouth, from Figure 18*e*, mouth is to left, × 8000; *c*, glandular openings near middle of left, distal, lateral glandular field shown in Figure 18*c*, × 3200; *d*, same from near top of field, from Figure 18*c*, (streamer from upper left glandular opening is probably debris), × 3000; *e*, upper left glandular opening in "d," × 7500; *f*, upper right glandular opening in "d," × 8250. (Photos reduced for publication to 74 percent.)

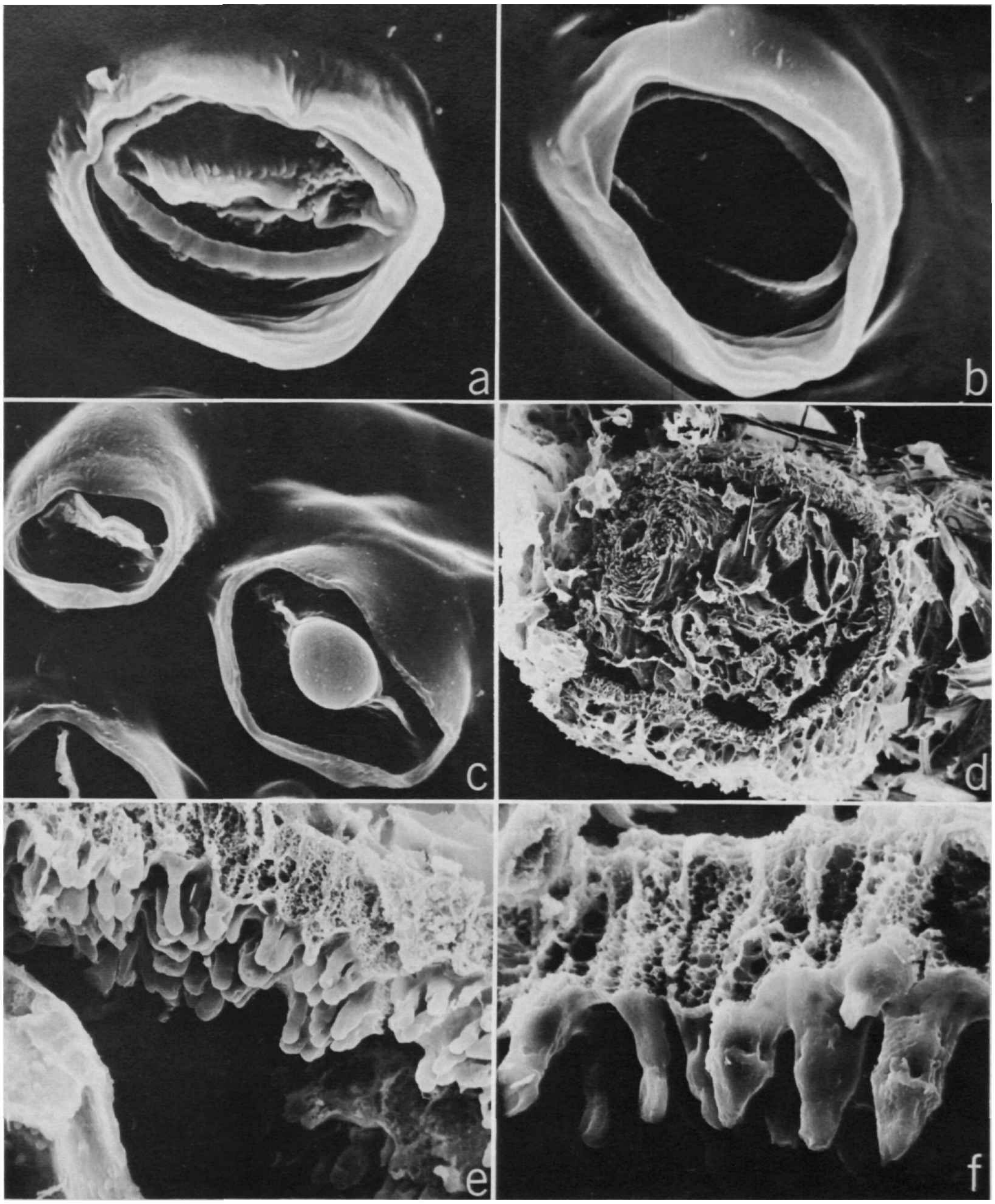

FIGURE 20.—*Gigantocypris muelleri*, USNM 151983, instar IV female upper lip and stomach: *a*, glandular opening from near upper middle of left, distal, lateral glandular field in Figure 18*c*, × 6350; *b*, glandular opening from lower part of left, proximal lateral glandular field in Figure 18*c*; *c*, glandular openings from near middle of main glandular field, from Figure 18*d*, × 3000; *d*, cut through stomach filled with food, from right end of Figure 18*a* (arrow points to stomach wall), × 54; *e*, pappilate inner surface of stomach wall near arrow in "d," × 550; *f*, same, × 1100. (Photos reduced for publication to 74 percent.)

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