

## Separation of *Alona cambouei* Guerne & Richard, 1893 from *Alona pulchella* King, 1853 (Branchiopoda: Anomopoda: Chydoridae)

## Различия между *Alona cambouei* Guerne & Richard, 1893 и *Alona pulchella* King, 1853 (Branchiopoda: Anomopoda: Chydoridae)

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**ABSTRACT:** A detailed revision of the *pulchella*-group of *Alona* Baird, 1843 in Asia, Africa and Australia reveals that *A. pulchella* King, 1853 and *A. cambouei* Guerne & Richard, 1893 are separate species, not synonyms as presumed by some authors. The main character that separates these species is the morphology of the major head pores, which are connected in *A. pulchella* and disconnected in *A. cambouei*. The distribution of the species seems to differ greatly. *A. pulchella* inhabits Australia, *A. cambouei* is distributed in Africa and tropical Asia, and is reported from Australia. The third nominal taxon of the group, *A. laevissima* Sars, 1988 is shown to be a synonym of *A. pulchella*.

**РЕЗЮМЕ:** Ревизия группы видов *pulchella* рода *Alona* Baird, 1843 в Азии, Африке и Австралии показывает, что *A. pulchella* King, 1853 и *A. cambouei* Guerne & Richard, 1893 являются независимыми видами, а не синонимами, как предполагалось многими авторами. Основной признак, отличающий эти виды — строение главных головных пор, которые соединены между собой у *A. pulchella* и не соединены *A. cambouei*. Ареалы этих видов существенно различаются. *A. pulchella* обитает в Австралии, в то время как *A. cambouei* встречается в Африке и тропической Азии, и, возможно, также представлена и в Австралии. Показано, что третий номинативный таксон группы, *A. laevissima* Sars, 1988 является синонимом *A. pulchella*.

### Introduction

Separation of *A. pulchella* and *A. cambouei* is one of most urgent problems in the taxonomy of the genus *Alona*. Specimens of *Alona* matching the general characteristics of the *pulchella* group — elongated postabdomen with parallel margins, very well developed later-

al fascicles of setae and moderately developed marginal denticles — can be found in Africa, Tropical Asia, Australia, South and Central America. Four species possessing these features have been described, but the characters that differentiate them were vague and uncertain. Detailed morphology was never studied for any members of *pulchella*-group. The general state of the group's taxonomy can be characterized as complete confusion, and the need for a revision of the *pulchella*-group is obvious. The aim of the present research was a revision of the *pulchella*-group of *Alona* in the Old World, including determination of validity of the species described from the Old World, and providing detailed descriptions of all valid species.

### Historical references

King's [1853] description of *A. pulchella* is rather short and far from detailed:

"Carapace subquadrangular, obliquely striate; dorsal edge rounded, anterior slightly curved, convex above, concave below, ciliated, setae of rami simple. The dorsal edge of the last joint of the abdomen is very slightly sinuated, but forms an obtuse angle near the joint. The terminal spines are long.

Habitat — Varroville, near Denham Court. St. Leonards, near Sydney."

This description is accompanied by four small figures — lateral view of female, postabdomen of female, dorsal view, and antennae. The two latter figures are of little value, so small that they would apply to almost any *Alona*. The sculpturing on the valves was depicted as only three straight lines, but King's drawings show the characteristic shape of the postabdomen, with parallel margins, well-developed lateral fascicles of setae, and more elongated than in most other *Alona* species.

Sars [1888] described another species *A. laevissima* among other species raised from dried mud from the neighborhood of Rockhampton, in Queensland. The description of this taxon was detailed and is accompanied by two good drawings — lateral view of female and postabdomen. His description of *A.*

*laeivissima* matches the general characters of the *pulchella* group — the shape and armature of postabdomen and elongated body. He pointed out the smooth valves, without any sculpturing, as one of the main distinctive characters of *A. laeivissima*.

Later, Sars [1896] found and described a population which he believed to be a true *A. pulchella* from the neighborhood of Sydney. He states: “This is, as I believe, the form originally recorded by Mr. King under the above name [i.e. *A. pulchella*]. It is closely allied to another Australian species described by the present author from the northern part of country as *A. laeivissima*. But in the latter form, as indicated by the specific name, the shell is perfectly smooth, whereas in the present species it exhibits the usual longitudinal striation” (p. 38). He characterised the valves of *A. pulchella* as “faintly striated” in the diagnosis (p. 38) or as “sculptured with distinct, though not very sharply marked, longitudinal striae” (p. 39) in a more detailed description. But after this work, *pulchella*-like specimens with such distinct striae, similar to that of *A. costata* Sars, 1862, were never reported. As in the case of *A. karua* King, 1853, [see Alonso & Pretus, 1989], or *A. diaphana* King, 1853 [see Frey, 1991], King’s original description provided little more than a name, and only Sars’ works establish the current meaning of the species.

In meantime Guerne and Richard [1893] described a species *A. cambouei* from Madagascar, which also shared the main characters of *pulchella*-group. Their description of this species is as follows:

“La longueur moyenne des femelles ovigères est de 0<sup>m</sup>45. La carapace est comprimée latéralement, allongée, et pas tout à fait deux fois plus longue que large (fig. 10). Le bord dorsal, depuis l’extrémité du rostre jusqu’à sa réunion en arrière avec le bord ventral, décrit une courbe régulière représentant à peu près une demi circonférence. Le bord ventral présente un peu avant son milieu, une légère convexité. Il est garni jusque près de son extrémité postérieure de soies médiocres. L’angle postéro-ventral est tout à fait arrondi. Le rostre est arrondi à son extrémité, quoique bien développé.

Chez la plupart des exemplaires, on voit, souvent avec quelque peine, une réticulation à mailles hexagonales lesquelles présentent en outre une ponctuation serrée qui se trouve sur toute la carapace. Sur certains individus, cette ponctuation paraît seule exister.

L’œil est de taille médiocre, ses lentilles cristallines paraissent noyées dans le pigment. La tache oculaire, notablement plus petite que l’œil, est un peu plus rapprochée de l’œil que de l’extrémité du rostre.

Les antennes antérieures atteignent à très peu près l’extrémité du rostre, elles sont presque cylindriques et portent à leur extrémité des soies sensorielles de longueur inégale, dont deux sont plus grandes que les autres. Les antennes postérieures ne présentent rien de particulier, la branche inférieure porte quatre soies, la branche supérieure en a trois. Il y a eu outre une épine à l’extrémité de chacune des branches et une semblable au côté externe du premier article de la branche supérieure.

Le labre, vu de côté, a son bord libre partout arrondi, les bords antérieur et postérieur sont à peu près parallèles.

Le postabdomen (fig. 11), court et large, présente la même largeur depuis son extrémité libre jusqu’à l’anus. La griffe terminale, qui paraît lisse, porte à sa base une épine grêle lisse, dont la longueur mesure environ un tiers de celle de la griffe. Le bord dorsal du postabdomen porte une série de 8 à 9 dents diminuant peu en longueur à mesure qu’on s’éloigne de l’extrémité libre. Chacune de ces dents (cela est surtout bien

visible pour les 4 ou 5 distales) porte à sa base et du côté proximal une petite dent beaucoup plus petite que la principale et difficile à voir. Outre cette rangée de dents qui s’arrête à l’anus, les côtés du postabdomen portent 5 ou 6 groupes ou peignes formés chacun d’épines extrêmement ténues et serrées dont la plus distale, dans chaque groupe, est la plus longue, et dépasse souvent le bord dorsal; les autres diminuent graduellement de longueur. Le sinus anal, bien marqué, est garni de petites épines extrêmement fines et courtes. L’angle supra-anal est très marqué. Les soies abdominales sont de grandeur médiocre et ne présentent rien de particulier.

Nous avons observé un exemplaire mâle de cette espèce. Il mesurait 0<sup>mm</sup>35 de long. Le bord dorsal est moins convexe que chez la femelle, le bord-postérieur est plus distinct du bord dorsal. Les griffes du postabdomen sont relativement plus robustes et plus courtes. Les six peignes latéraux du postabdomen sont bien développés tandis que les dents du bord dorsal font défaut et sont remplacées par de petites épines semblables à celles du sinus anal. La couleur dans les deux sexes est jaune.

Par certains caractères, cette espèce se rapproche beaucoup de *A. laeivissima* G.O.Sars, d’Australie, mais chez cette dernière l’angle supra-anal et le sinus anal sont beaucoup moins marqués, les dents du postabdomen présentent des caractères bien différents et le bord dorsal de la carapace fait avec le bord postérieur un angle qui ne se retrouve pas dans notre espèce.

*Alona Cambouei* a été pêchée avec *Canthocamptus Grandidieri* à Madagascar, aux environs de Tananarive, par M. Sikora.”

Their description was accompanied by two good drawings of female lateral view and postabdomen. Soon after that, one of the authors, Richard [1894], reported occurrence of this species in Egypt and Asia Minor.

One more species of this group, *A. glabra* Sars, 1901, was described from Argentina. This species also matched the general characters of group, and reasons for its separation were doubtful.

The differences between these four species were so vague, that first Daday [1910], and many authors after him [Fryer, 1957; Harding 1957; Megard, 1967; Olivier, 1962; Chiang & Du, 1979 and others] presumed *A. laeivissima*, *A. cambouei*, and *A. glabra* to be synonymous with *A. pulchella*. Gauthier [1939] even used the name *A. pulchella* var. *cambouei*. From the end of 1960, *A. laeivissima* and *A. glabra* were never treated as an independent species, with one exception — Smirnov & Timms [1983] included a description of *A. laeivissima* in their work on Australian cladocera, but they did not report any occurrences of this species themselves.

However, a number of authors treated *A. cambouei* as an independent species. While Fryer [1957: 230] assumed that “It will probably be generally agreed that the names *pulchella* and *cambouei* refer at utmost to variants of a single species”, Smirnov [1971] and Smirnov & Timms [1983] treated these two species as independent. The main reason for separation of *A. cambouei* was not quite parallel ventral and dorsal margins of postabdomen and presence of weak hexagons on the valves. These features, according to most recent authors, are not enough for separation of species in Chydoridae.

The name *A. pulchella* was used for specimens from Australia, Asia [Petkovski, 1966; Nayar, 1971; Sharma & Towari 1981; Rajapaksa & Fernando, 1987; Chen, 1993 and others], Africa [Daday, 1910; Gauthier, 1939; Rey & Saint-Jean, 1968; Dumont et al., 1984 and others] and South America [Megard, 1967; Olivier, 1962, and many others].

Likewise, the name *A. cambouei* was used for *pulchella*-like specimens from Africa, Asia [Richard, 1984; Manuilova, 1964; Mukhameddiev, 1986; Smirnov, 1971 and others], Australia [Smirnov, 1971; Smirnov & Timms, 1986] and South America [Richard, 1897 and others]. Descriptions of animals provided in most of above works are far from detailed. Usually only general morphology of female and female postabdomen were described. Morphology of trunk limbs, antennae and antenna was studied only once for the specimens from Australia [Smirnov, 1971], treated by the author as *A. cambouei*.

The present state of taxonomy in the *pulchella*-group can be characterized as complete confusion. Most authors ascribe the studied specimens to *A. cambouei* or *A. pulchella* without significant reasons. According to Smirnov [1971] and other authors, distributions of these two species are completely overlapping, which also adds to the confusion.

At first sight, Fryer's [1957] opinion of the identity of *A. pulchella* and *A. cambouei* should be taken. But examination of head pores of *pulchella*-like species suggested that at least two different species of this group are present in the Western Hemisphere. Several authors report species named by them *A. pulchella* with disconnected main head pores from India [Sharma & Towari 1981; Rajapaksa & Fernando, 1987], and China [Chen, 1993]. But according to Smirnov [1971], specimens from Australia, named by him *A. cambouei*, have connected major head pores.

## Material and Methods

The studied material include three G.O. Sars' original samples of *A. pulchella* and *A. laevisissima* from Australia, and several samples from Australia, Central Asia, and North Africa. Animals were selected from samples under a binocular stereoscopic microscope, placed on slides (in a drop of a glycerol-ethanol mixture) and studied under the optical microscope. Several specimens from each sample, save Sars' material, were dissected for analysis of appendages. About 30 specimens from several samples were lyophilised, mounted on an aluminium stub, coated with gold, and examined under a scanning electron microscope (Hitachi S 405-A). All specimens were measured using an eyepiece-micrometer. Drawings were made with camera lucida.

### ABBREVIATIONS

*In the list of material:* NMK — collection of Dr. N.M. Korovchinsky, Moscow; NNS — collection of Prof. N.N. Smirnov, now at the Zoological Museum of Moscow State University, but not officially deposited to it; ZMOU — Zoological Museum of Oslo University.

*In illustrations and text:* I–V — thoracic limbs I–V; as — accessory seta of limb I; e1–3 — endites 1–3 of limb I; IDL — inner distal lobe of limb I; IP — interpore distance (distance between anterior and posterior major head pores); ODL — outer distal lobe of limb I; PP — postpore distance (distance between posterior head pore and posterior corner of head shield); s — sensillum.

## Results

Since the type material from both King and Guerne and Richard has been lost, the first step was to investi-

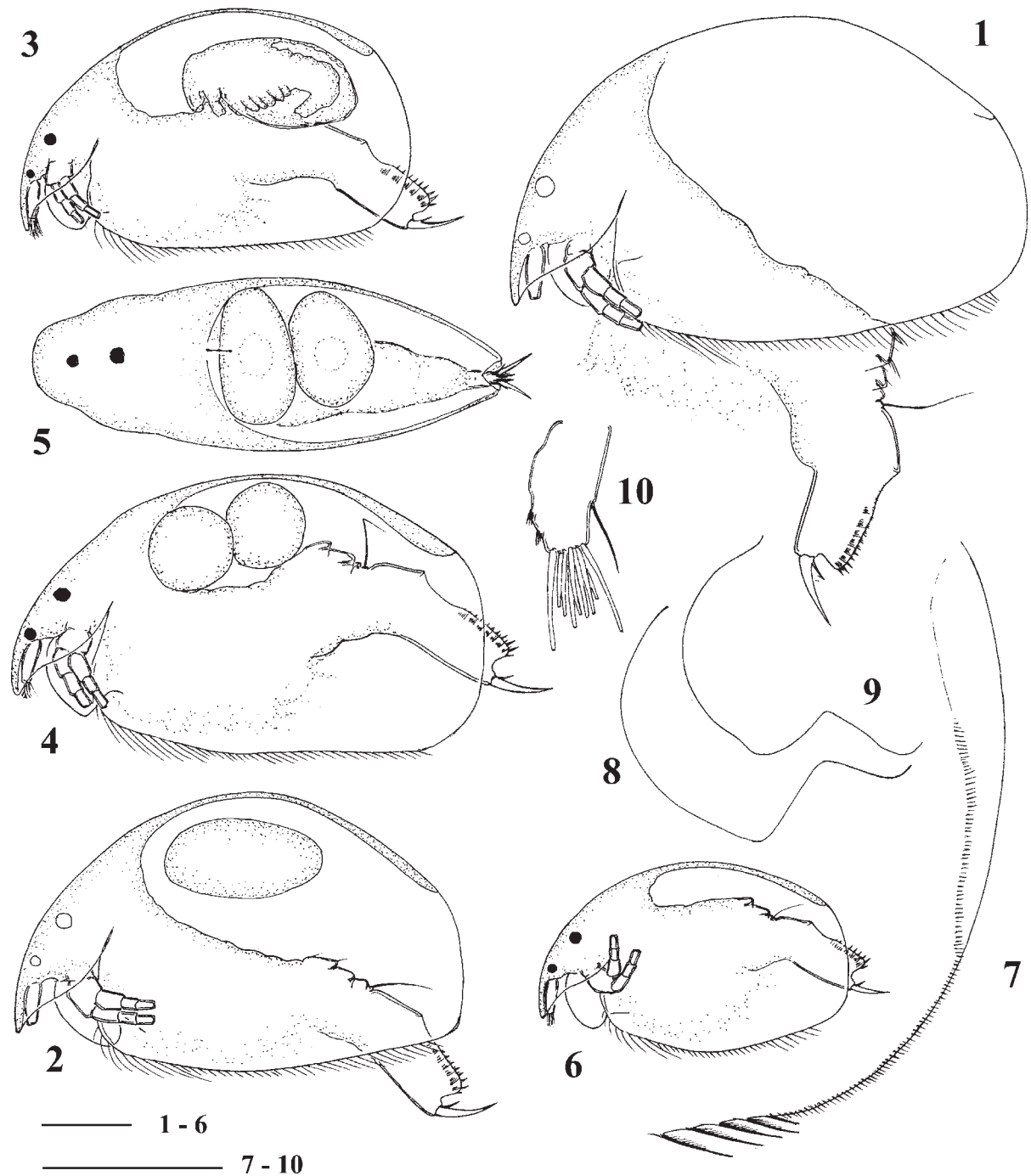
gate Sars' material of *A. pulchella* and the type material of *A. laevisissima*, which was deposited in the Zoological Museum of Oslo University. All samples remaining from Sars' were examined; they include two samples labelled as *A. pulchella* and one sample and one slide labelled as *A. laevisissima*.

It is logical to presume that the sample labeled "*A. pulchella*, Australia, Ramsay" was the material Sars [1896, p. 39] refers to: "Some few specimens of this form [i. e. *A. pulchella*] all of them females, were found in the sample at first received from Prof. Ramsay, and taken from the Waterloo Swamps". But examination of this sample revealed that instead of one species, two were present in it — 6 specimens of *A. setigera* Brehm, 1931, the species of *costata*-group with distinct striae on carapace and postabdomens narrowing distally [for description of this species see Sinev, 2000], and 11 *pulchella*-like specimens with characteristic morphology of the postabdomen, but with completely smooth valves. Not a single specimen matching Sars description — with striae on valves and postabdomen of *pulchella*-type was present! It seems to me that Sars depicted and described a non-existent animal, combining characters of two different species — the sculpturing on the valves from *A. setigera* and shape of the postabdomen from a *pulchella*-group animal. This agrees well with the fact that *pulchella*-like specimens with such distinct striae were never reported again.

In Sars' second sample labeled as *A. pulchella*, all specimens present also have smooth valves. Comparison of all Sars' samples and our additional material, 2 samples from Australia, reveals that they all contain one and the same species, in all cases specimens have smooth valves and three connected major head pores. My conclusion is that the both names *A. pulchella* King, 1853 in Sars' interpretation and *A. laevisissima* Sars, 1888 belong to one species. Despite King's [1853] short and uncertain descriptions, Alonso & Pretus, [1989] and Frey [1991] retained his names *A. karua* King, 1853 and *A. diaphana* King, 1853, respectively, as valid. Following the example of these authors, I conclude that the name *A. pulchella* also should be retained and *A. laevisissima* Sars, 1888 should be treated as a junior synonym.

Examination of 4 samples from North Africa and Middle Asia reveals that in all of them specimens with disconnected major head pores are present, similar to those reported from India and China [Sharma & Towari, 1981; Rajapaksa & Fernando, 1987; Chen, 1993]. Also, there are several minor differences between these specimens and *A. pulchella* s. str. from Australia. While no samples from Madagascar, the type locality of *A. cambouei*, were studied, I have the following reasons to treat these specimens as *A. cambouei*. First, the morphology of the specimens studied completely agrees with the original description of this species. Second, one of the authors of *A. cambouei*, Richard [1894] reports the occurrence of this species in Egypt and Asia Minor.

When the manuscript was almost complete, one more sample from Australia (Queensland, 40 km East of



Figs 1-10. *Alona pulchella* King, 1863 from Australia (1-2 — from New South Wales, Waterloo swamp, specimens from G.O. Sars collection; 3-9 — Queensland, 10 km west of Rockhampton, Gracemere Lagoon) parthenogenetic females: 1-3 — lateral view, 4-5 — lateral and dorsal view of the same specimen, 6 — juvenile female of instar II, 7 — postero-ventral angle and posterior margin of valves, 8-9 — labrum, 10 — antennule. Scale bars: 0.1 mm (1-6), 0.05 mm (7-10).

Рис.1-10. *Alona pulchella* King, 1863 из Австралии (1-2 — Новый Южный Уэльс, болота Ватерлоо, экземпляры из коллекции Г. О. Сарса; 3-9 — Квинсленд, 10 км западнее Рокгэмптона, озеро Грэйсмере) партеногенетические самки: 1-3 — вид сбоку, 4-5 — один и тот же экземпляр, вид сбоку и сверху, 6 — ювенильная самка второго возраста, 7 — задне-нижний угол и задний край створок, 8-9 — лярбрум, 10 — антеннула. Масштаб 0,1 мм (1-6), 0,05 мм (7-10).



Hungerford, Lake Wombah) was supplied by Pr. B.V. Timms. It contained *pulchella*-like animals with disconnected head pores, as in *A. cambouei*. But at present I am not able to determine the exact taxonomic status of this population and I am not sure in its relationship to *A. cambouei*.

The detailed descriptions of the two species follows.

#### *Alona pulchella* King, 1983

King, 1853: 260, pl VIII; Sars, 1888: 59–62, fig 5–6 (*laevisima*); Smirnov, 1971: 373, fig 442 (*pulchella*), fig. 444–446 (*cambouei*); Smirnov & Timms, 1986: 41–43, fig 42 (*cambouei*), 49, fig. 56.

Material examined

Material from G.O. Sars collection:

11 parthenogenetic females from Australia (labelled Australia, Ramsey — obviously collected by Prof. Ramsey in Waterloo Swamps in the neighbourhood of Sydney, N.S.W. — the material referred to by Sars [1896] ZMOU, F4155;

17 parthenogenetic females from Australia, Victoria (no more precise location), ZMOU, F19283;

over 40 parthenogenetic females originally labeled *A. laevisima* from Australia, Queensland, near Gracemere (the type location of *A. laevisima*), ZMOU, F18327;

12 parthenogenetic females on a slide from Australia, originally labeled *A. laevisima* (possibly also from the type location of *A. laevisima*), ZMOU, F9640.

Additional material:

102 parthenogenetic females from Australia, New South Wales, Lake Albert near Wagga-Wagga, 29.XI.1973, leg. B. Timms (loc. 184 in Smirnov & Timms, 1983), NNS-2000-138;

40 parthenogenetic females from Australia, Queensland, 10 km West of Rockhampton, Gracemere Lagoon, 11.VI.1974, (loc. 39 in Smirnov & Timms, 1983), leg. unknown, NMK-0996.

**DIAGNOSIS. Female:** Body oval, length about 1.6–1.7 times maximum height. 40–45 setae at ventral margin significantly differentiated in size. Postero-ventral corner without denticles. Head shield elongated, with broadly rounded, notched posterior margin, rostrum short and rounded. Three major head pores with a narrow connection between them. Central pore smaller or equal to anterior or posterior one, located at the middle. PP = 0.45–0.55 IP. Lateral head pores located in small depressions about 0.9–1 IP distance from midline, almost at level of anterior major head pore. Labrum of moderate size, labral keel broad, rounded, with a blunt apex, without any clusters of setules on posterior margin of keel.

Postabdomen relatively narrow, with parallel margins, length about 2.8–3 height. Inflated basis of claws bordered from distal margin by clear incision. Distal margin straight, rounded angle between distal and dorsal margins. Dorsal margin with distal part about 1.7–2 times longer than preanal one, with postanal portion 1.5 times longer than anal one. Preanal angle usually well expressed, postanal angle weakly defined. Preanal margin straight.

Postabdomen with 8–10 well-developed, sharp, slender marginal denticles, gradually passing into 3–5 groups of marginal setules on anal margin. 8–11 lateral fascicles of long setules, posteriormost setae of each fascicle longest, longer than marginal denticles; additional row of 2–3 fascicles above the row of lateral fascicles in preanal region. Postabdominal claw of moderate length, subequal to preanal portion of postabdomen. Basal spine ca. 0.25–0.3 of the claw length.

Antennule short. Nine aesthetascs, two of them longer than the others. All aesthetascs projecting beyond anterior margin of the head shield. Antennal formula, setae 0-0-3/1-1-3, spines 1-0-1/0-0-1. Seta arising from basal segment of endopod thin, projecting well beyond tip of distal segment.

Spine on basal segment of exopod shorter than middle segment. Spines on apical segments little longer than apical segments.

IDL of trunk limb I with three setae, first of these short, thin, others long, well-developed. Gnathobase of limb II of usual shape. Exopodite of trunk limb III with seven setae greatly different in length, 5<sup>th</sup> being longest. Exopodite IV with six setae. Exopodite V with four setae. Epipodites IV and V with very short projections. Trunk limb VI absent.

Length 0.37–0.53 mm.

Male unknown.

**REDESCRIPTION. PARTHENOGENETIC FEMALE.**

**General:** In lateral view body oval (Figs 1–3, 5–6, 20–21), relatively low, maximum height at middle of body. In adults length ca. 1.6–1.7 times maximum height. Dorsal margin uniformly curved, depression between head and rest of body absent. Postero-dorsal and postero-ventral angles broadly rounded. Posterior margin convex. About 50–70 short setules of equal length at postero-dorsal angle, these setules not organized into groups (Figs 7, 23–24). A row of about 60 setules along posterior margin at some distance from one on inner side of carapace, these setules not organized into groups. Ventral margin almost straight, with 40–45 setae (Figs 11–12), anteriormost 7–9 setae long, next 10–12 setae very short, after that length of setae increase posteriorly. Antero-ventral angle rounded. Carapace without any reticulation (Figs 21–22).

**Head** relatively small, triangular-round in lateral view. In lateral view rostrum well developed, protruding downward. Eye larger than ocellus. Distance from tip of rostrum to ocellus slightly greater than that between ocellus and eye.

**Head shield** (Fig. 13) elongated, with maximum width behind mandibular articulation, length ca. 1.6 times maximum width. Rostrum short, broadly rounded. Posterior margin broadly rounded, with 10 or 12 notches. Three major head pores with a narrow connection between them (Figs 14–15, 25). Central pore smaller or equal to anterior or posterior one, located at the middle. PP = 0.45–0.55 IP. Lateral head pores located in small depressions about 0.9–1 IP distance from midline, almost at level of anterior major head pore.

**Labrum** of moderate size (Figs 8–9). Distal labral plate without setulation. Labral keel wide, rounded, with a blunt apex. Anterior margin of keel convex, posterior margin without any clusters of setules. No special lateral projections on labrum and no special folds surrounding its base.

**Thorax and abdomen** subequal in length, more elongated than in most other species of *Alona*, dorsal surface of abdominal segments not saddle-shaped. No abdominal projections. First abdominal segment with two transverse rows of short setules.

**Postabdomen** relatively narrow, with parallel margins, length about 2.8–3 height (Figs 16–18). Ventral margin from straight to slightly convex. Inflated basis of claws bordered from distal margin by clear incision. Distal margin straight, rounded angle between distal and dorsal margins. Dorsal margin with distal part about 1.7–2 times longer than preanal one, with postanal portion 1.5 times longer than anal one. Preanal angle usually well expressed, postanal angle weakly defined. Preanal margin straight.

Postabdomen with 8–10 well-developed, sharp, slender marginal denticles, and 3–5 groups of marginal setules on anal margin. Only 3–6 posteriormost denticles are single, others with additional 1–3 smaller denticles near base. 8–11 lateral fascicles of long setules, posteriormost setae of each fascicle thickest and longest, longer than marginal denticles; additional row of 2–3 fascicles above the row of lateral fascicles in preanal region.

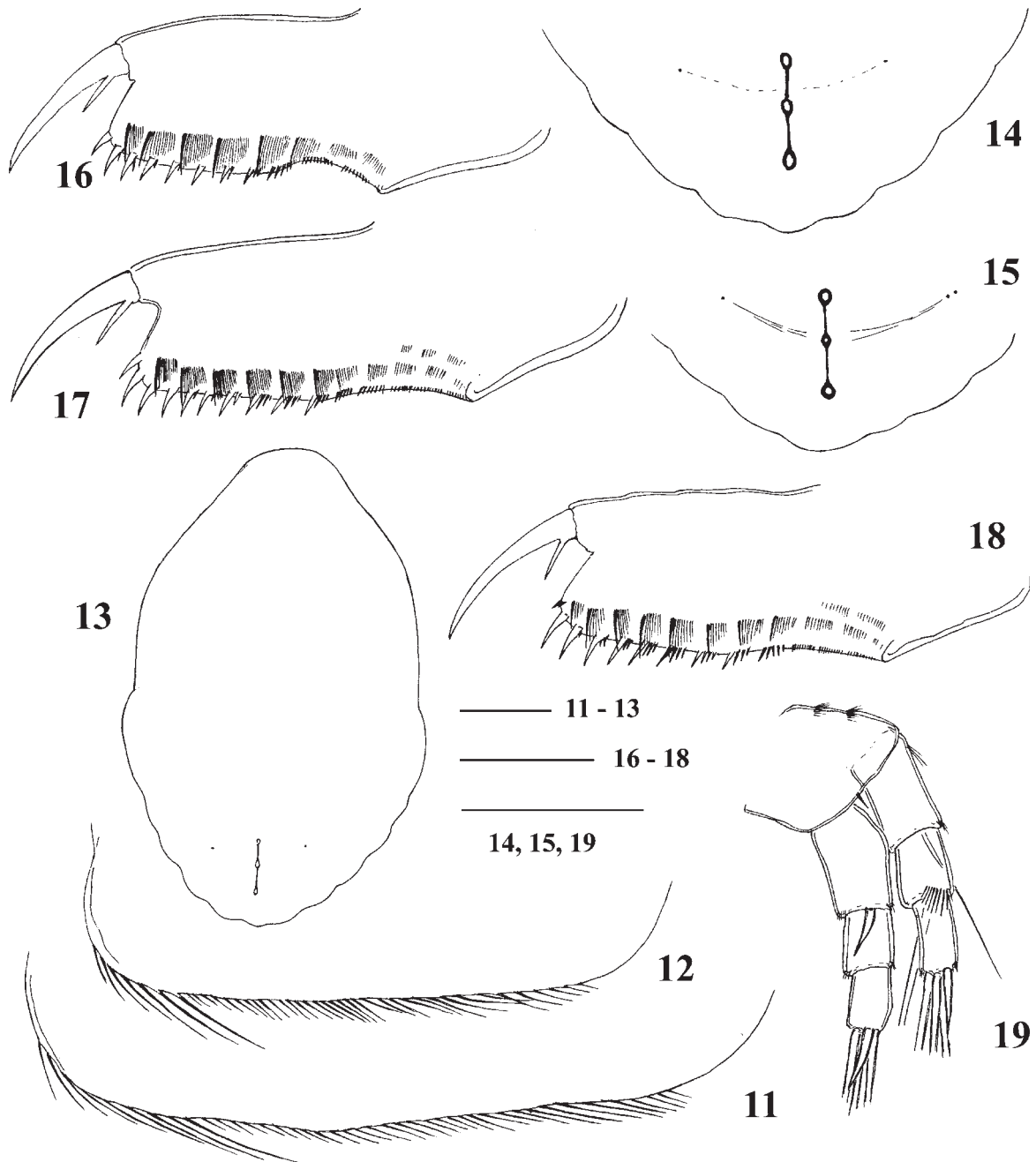


Fig. 11–19. *Alona pulchella* King, 1863 from Australia, Queensland, 10 km west of Rockhampton, Gracemere Lagoon, parthenogenetic females: 11–12 — ventral margins of valves, 13 — head shield, 14–15 — head pores, 16–18 — postabdomens, 19 — antennae. Scale bars: 0.05 mm.

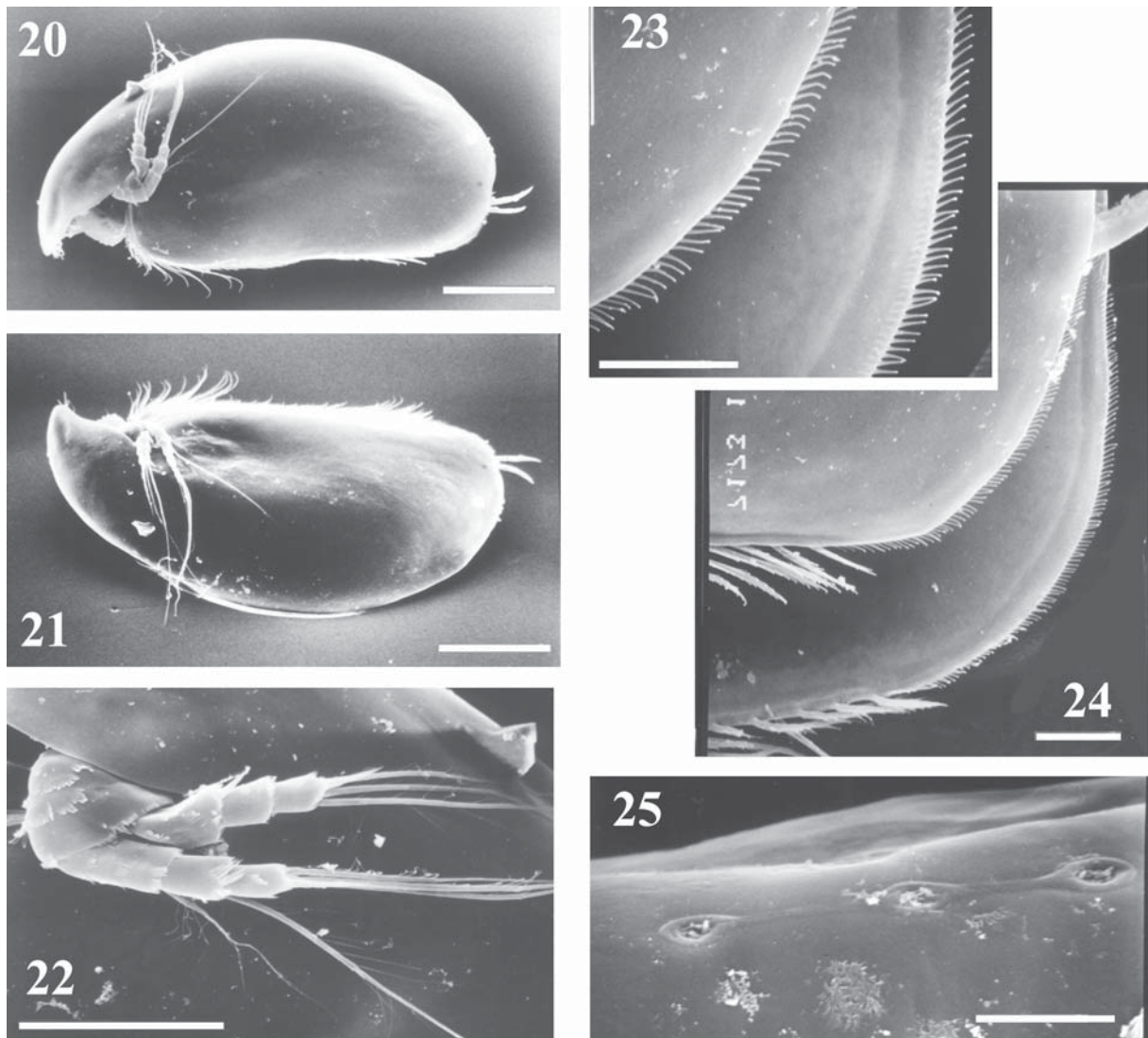
Рис. 11–19. *Alona pulchella* King, 1863 из Австралии, Квинсленд, 10 км западнее Рокгэмптона, озеро Грэйсмере, партеногенетическая самка: 11–12 — нижний край створок, 13 — головной щит, 14–15 — головные поры, 16–18 — постабдомен, 19 — антенна. Масштаб 0,05 мм.

*Postabdominal claw* of moderate length, subequal to preanal portion of postabdomen. Basal spine slender, sharp, ca. 0.25–0.3 of the claw length.

*Antennule* relatively short, robust, not reaching the tip of rostrum, with 2–3 transverse rows of setules at anterior face (Fig. 10). Antennular sensory seta slender, two times shorter

than antennule, arising at 2/3 distance from the base. Nine aesthetascs, two of them long and thick, of about 2/3 length of antennule, others relatively short, of similar size. All aesthetascs projecting beyond anterior margin of the head shield.

*Antenna* short (Figs 19, 22). Antennal formula, setae 0-0-3/1-1-3, spines 1-0-1/0-0-1. Basal segment robust, branches



Figs 20–25. *Alona pulchella* King, 1863 from Australia, Queensland, 10 km west of Rockhampton, Gracemere Lagoon, parthenogenetic female: 20 — lateral view, 21 dorso-lateral view, 22 — antenna, 23–24 — posterodorsal angle of valves, 25 — major head pores. Scale bars: 0.1 mm (20–21), 0.05 mm (22), and 0.01 mm (23–25).

Рис. 20–25. *Alona pulchella* King, 1863 из Австралии, Квинсленд, 10 км западнее Рокгэмптона, озеро Грэйсмере, партеногенетические самки: 20 — вид сбоку, 21 — вид сбоку-верху, 22 — антенна, 23–24 — задне-нижний угол створок, 25 — главные головные поры. Масштаб 0,1 мм (20–21), 0,05 мм (22), 0,01 мм (23–25).

relatively elongated, all segments cylindrical, with short setules around distal margin. Seta arising from basal segment of endopod thin, projecting well beyond tip of distal segment. Seta arising from middle segment of endopod of similar size with apical setae. Spine on basal segment of exopod shorter than middle segment. Spine from apical segment of exopod longer than this segment. Apical spine of endopod longer than this segment.

*Trunk limbs*: five pairs.

*Trunk limb I* of moderate size (Figs 26–27). Epipodite oval, without finger-like projection.

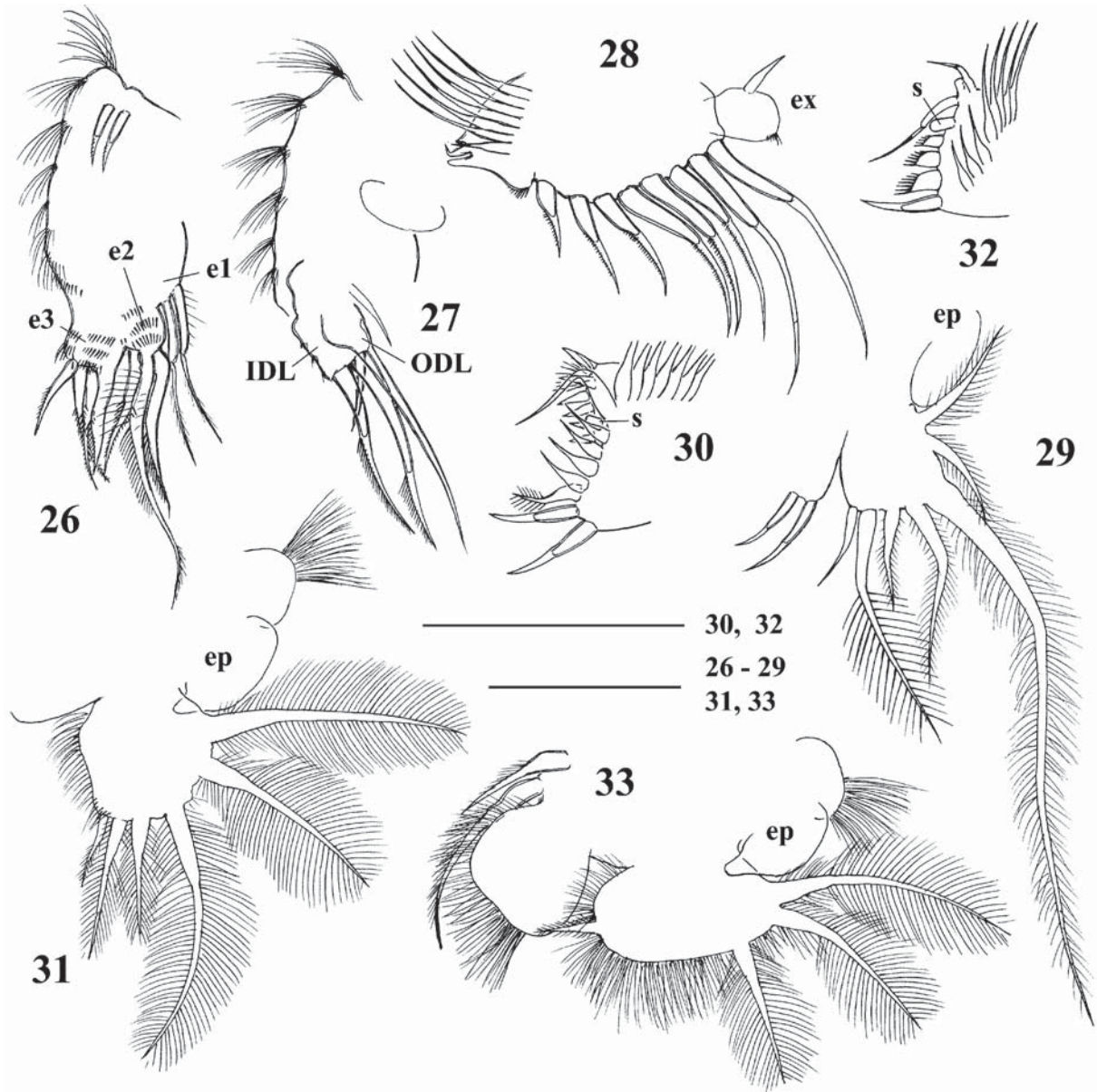
Accessory seta short, thin, setulation on it not visible under optical microscope. ODL with one long seta, IDL with three setae and 3 clusters of small setules on ventral face, 1<sup>st</sup>

IDL seta short, pointed, 2<sup>nd</sup> and 3<sup>rd</sup> IDL setae 2-segmented, subequal in length, both with setules in distal part.

Endite 3 with four setae, ventralmost seta much shorter and thinner than others. On endite 2 there are three densely feathered setae, middle of them longer than ODL seta. Endite 1 with two 2-segmented setae, both setulated in distal part. No naked setae on anterior face of limb visible under optical microscope. Seven rows of thin long setules on ventral face of limb. Two ejector hooks of similar size. No maxillary process was found.

*Trunk limb II* triangle-round (Fig. 28). Exopodite globular, with one slender, naked seta. Inner portion of limb (“endopodite”) with eight scraping spines increasing progressively in length distally, with equally thin setules on each. A portion of gnathobase bordering with “endopodite” setulated. Distal





Figs 26–33. *Alona pulchella* King, 1863 from Australia, Queensland, 10 km west of Rockhampton, Gracemere Lagoon, parthenogenetic female: 26–27 — limb I in inside and outside view, 28 — limb II, 29 — exopodite of limb III, 30 — inner portion of limb III, 31 — exopodite of limb IV, 32 — inner portion of limb IV, 33 — limb V. Scale bars: 0.05 mm.

Рис. 26–33. *Alona pulchella* King, 1863 из Австралии, Квинсленд, 10 км западнее Рокгэмптона, озеро Грэйсмере, партеногенетическая самка: 26–27 — нога I, вид изнутри и снаружи, 28 — нога II, 29 — экзоподит ноги III, 30 — внутренняя часть ноги III, 31 — экзоподит ноги IV, 32 — внутренняя часть ноги IV, 33 — нога V. Масштаб 0,05 мм.

armature of gnathobase with three elements. Filter plate II with seven setae, the posteriormost member considerably shorter.

*Trunk limb III:* epipodite oval, without finger-like projection. Exopodite subrectangular (Fig. 29), with seven setae, subdivided into distal and basal groups. 5<sup>th</sup> (from exopodite) distal setae longest, feathered by long setules, 2<sup>nd</sup> three times shorter than 5<sup>th</sup>, with very long, thick setules in distal part, other distal and lateral setae shorter than 2<sup>nd</sup>, of them 1<sup>st</sup> distal setae naked, other setulated by short setules.

Distal endite with 3 setae, two distalmost members slender, sharp, with distal segments unilaterally armed with short

setules; basalmost seta flattened, bilaterally armed with long setules (Fig. 30). Basal endite with 4 stiff, naked setae, increasing in size in basal direction. Gnathobase not clearly separated from basal endite. Four soft setae increasing in size basally. Distal armature of gnathobase with 4 elements. The first one elongated, cylindrical sensillum, the second geniculated seta, others two spines with fused bases. A bunch of setules near them. Filter plate III with seven setae.

*Trunk limb IV:* Pre-epipodite ovoid, setulated; epipodite globular, with short finger-like process. Exopodite of irregular shape, with six setae (Fig. 31). Two lateral setae flattened,



plumose, one two times longer than other. Four distal setae of greatly unequal size, distalmost member shorter than longest of lateral setae, other much longer. Inner portion of limb IV with four setae (Fig. 32). Distalmost seta naked, stout, 3 others flattened, with reduced distal part, each armed with 5-8 thick setules on distal margin. 3 soft setae increasing in size basally. Gnathobase with a long 2-segmented seta, small hillock distally, and additional geniculated naked seta near it. Filter plate with five setae.

Trunk limb V: pre-epipodite setulated. Epipodite elliptical, with short finger-like process (Fig. 33). Exopodite regular oval, not subdivided into two lobes, lateral group with 3 long, densely setulated setae, distally only a single short seta. Inner limb portion as distally widening lobe, with setulated inner margin. At inner face, two densely setulated setae, distalmost very large. No filter plate was found.

Trunk limb VI absent.

EPHIPPIAL FEMALE and MALE unknown. There are no data on male morphology which refer to the male of *A. pulchella* s. str. with certainty.

SIZE: No juvenile females of first instar were present in studied material despite the large number of specimens. In females of second juvenile instar II, length 0.31 to 0.35 mm, height 0.19 to 0.21 mm. In adult female, length 0.37 to 0.53 mm, height 0.24 to 0.32 mm.

#### *Alona cambouei* Guerne & Richard, 1983

Guerne & Richard, 1893: 224-244, fig. 10-11; Richard, 1894: 371-374, fig. 5-8; Daday, 1910: 128-130, Taf. 6, Fig. 30-35 (*pulchella*); Rey & Saint-Jean, 1968: 11, Fig 25, A-D (*pulchella*); Rajapaksa & Fernando, 1987, fig. 139 (*pulchella*); Dumont et al., 1984: 166-167, fig 2, 1-2 (*pulchella*); Chen, 1993: 27, fig. 1-5 (*pulchella*); Venkataraman, 1993: 382-383, fig. 34-37 (*pulchella*);

Material examined:

16 parthenogenetic females from Sudan, White Nile River, more precise location and date unknown, NNS-2000-104;

34 parthenogenetic females from Iraq, water body in Chybayish, 18.IX.1974, NNS-2000-109;

13 parthenogenetic females from Iraq, water body in Basrah, no date, NNS-2000-135;

11 parthenogenetic females Uzbekistan, Tashkent Area, pond of Kalgan-Chirgik fish farm, 22.VII.1961, NNS-2000-108.

DIAGNOSIS. *Female*: Body oval, length about 1.6-1.7 times maximum height. 30-35 setae at ventral margin significantly differentiated in size. Postero-ventral corner without denticles. Head shield elongated, with broadly rounded, notched posterior margin, rostrum short and rounded. Three major head pores without connection between them. Central pore smaller than anterior or posterior one, located at the middle. PP = 0.25-0.4 IP. Lateral head pores located in small depressions about 1.3-1.5 IP distance from midline, almost at level of anterior major head pore. Labrum of moderate size, labral keel broad, rounded, with a blunt apex, without any clusters of setules on posterior margin of keel.

Postabdomen relatively narrow, with parallel margins, length about 2.8-2.9 height. Inflated basis of claws bordered from distal margin by clear incision. Distal margin straight, rounded angle between distal and dorsal margins. Dorsal margin with distal part about 1.7-2 times longer than preanal one, with postanal portion 1.5 times longer than anal one. Preanal angle prominent, postanal angle weakly defined. Preanal margin straight.

Postabdomen with 7-10 well-developed, sharp, slender marginal denticles, evenly passing into 3-5 groups of marginal setules on anal margin. 8-10 lateral fascicles of long setules, posteriormost setae of each fascicle longest, longer than marginal denticles. Postabdominal claw of moderate

length, subequal to preanal portion of postabdomen. Basal spine ca. 0.25-0.3 of the claw length.

Antennule short. Nine aesthetascs, two of them longer than others. All aesthetascs projecting beyond anterior margin of the head shield. Antennal formula, setae 0-0-3/1-1-3, spines 1-0-1/0-0-1. Seta arising from basal segment of endopod thin, projecting beyond tip of distal segment. Spine on basal segment of exopod shorter than middle segment. Spines on apical segments little longer than apical segments.

IDL of trunk limb I with three setae, first of these short, thin, others long, well-developed. Gnathobase of limb II of usual shape. Exopodite of trunk limb III with seven setae greatly different in length, 5<sup>th</sup> being longest. Exopodite IV with six setae. Exopodite V with four setae. Epipodites IV and V with very short projections. Trunk limb VI absent.

Length 0.35-0.46 mm.

*Male*: body is more elongated than in female, length about 2 times maximum height. Postabdomen narrow, with parallel margins. Ventral margin almost straight, with strong step in region of gonopores, which open ventrally near basis of claws. Dorsal margin almost straight, preanal angle well-defined, postanal angle not defined. Lateral fascicles of setules same as in female, clusters of short setules in place of marginal denticles.

Length: 0.32-0.35 mm.

REDESCRIPTION. PARTHENOGENETIC FEMALE.

*General*: In lateral view body oval (Figs 34, 36-38, 46, 48), relatively low, maximum height at middle of body. In adults length ca. 1.6-1.7 times maximum height. Dorsal margin uniformly curved, depression between head and rest of body absent. Postero-dorsal and postero-ventral angles broadly rounded. Posterior margin convex. About 50-70 short setules of equal length at postero-dorsal angle, these setules not organized into groups (Figs 50-51, 54). A row of about 60 setules along posterior margin at some distance from one on inner side of carapace, these setules not organized into groups. Ventral margin almost straight, with 30-35 setae (Fig. 39), anteriormost 7-9 setae long, next 15-18 setae very short, posteriormost 14-16 setae of intermediate length, with length of setae increase posteriorly. Antero-ventral angle rounded. Carapace without any reticulation (Figs 46-48).

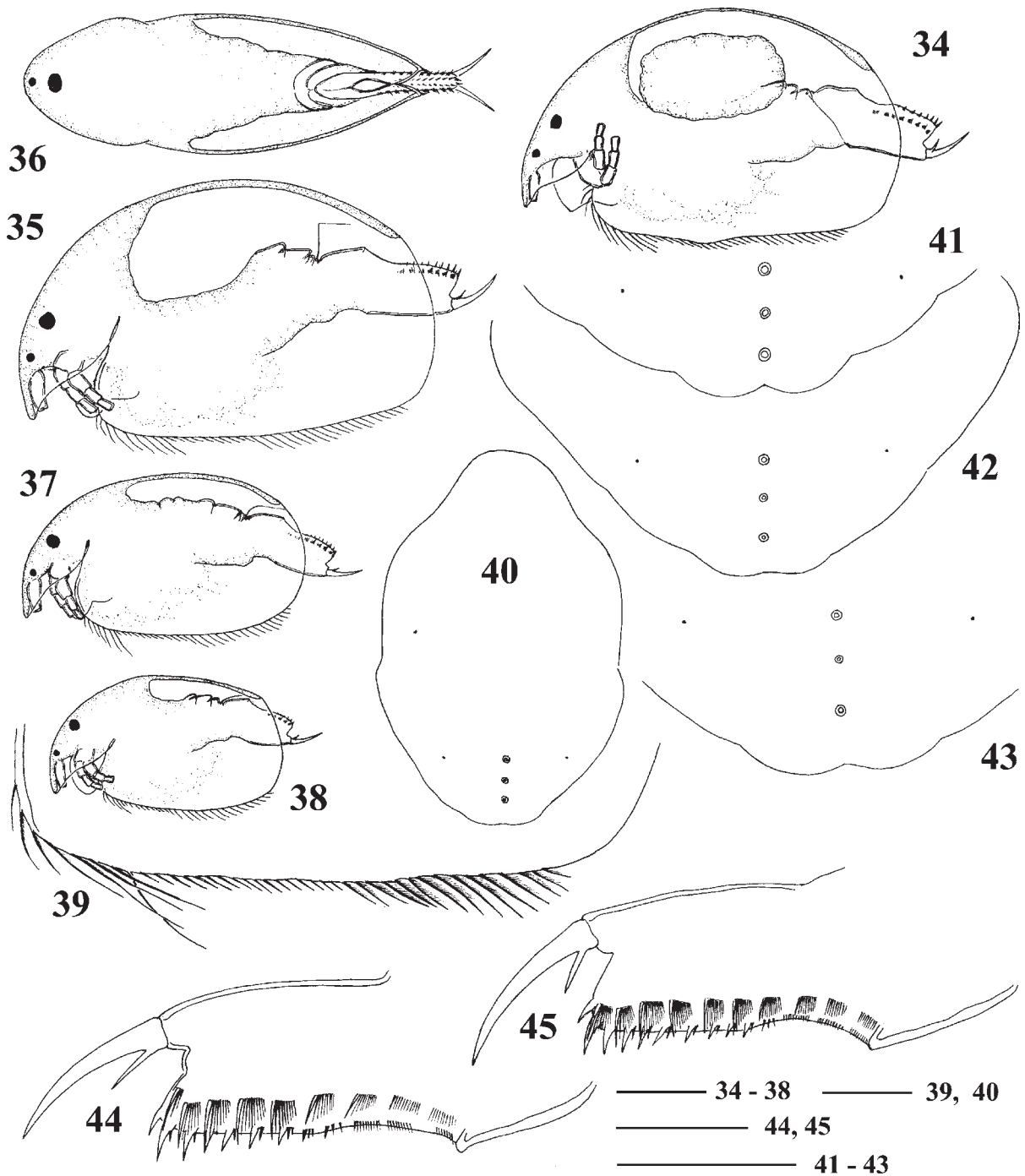
*Head* relatively small, triangular-round in lateral view. In lateral view rostrum well developed, protruding downward. Eye larger than ocellus. Distance from tip of rostrum to ocellus slightly greater than that between ocellus and eye.

Head shield (Fig. 40) elongated, with maximum width behind mandibular articulation, length ca. 1.6 times maximum width. Rostrum short, broadly rounded. Posterior margin broadly rounded, with 5 or 7 notches. Three major head pores without connection between them (Figs 41-43, 52-53). Central pore smaller than anterior or posterior one, located at the middle. PP = 0.25-0.4 IP. Minute lateral head pores located in small depressions about 1.3-1.5 IP distance from midline, almost at level of anterior major head pore.

*Labrum* of moderate size (Figs 55-56). Distal labral plate without setulation. Labral keel wide, rounded, with a blunt apex. Anterior margin of keel convex, rarely irregular (Fig. 55) posterior margin without any clusters of setules. No special lateral projections on labrum and no special folds surrounding its base.

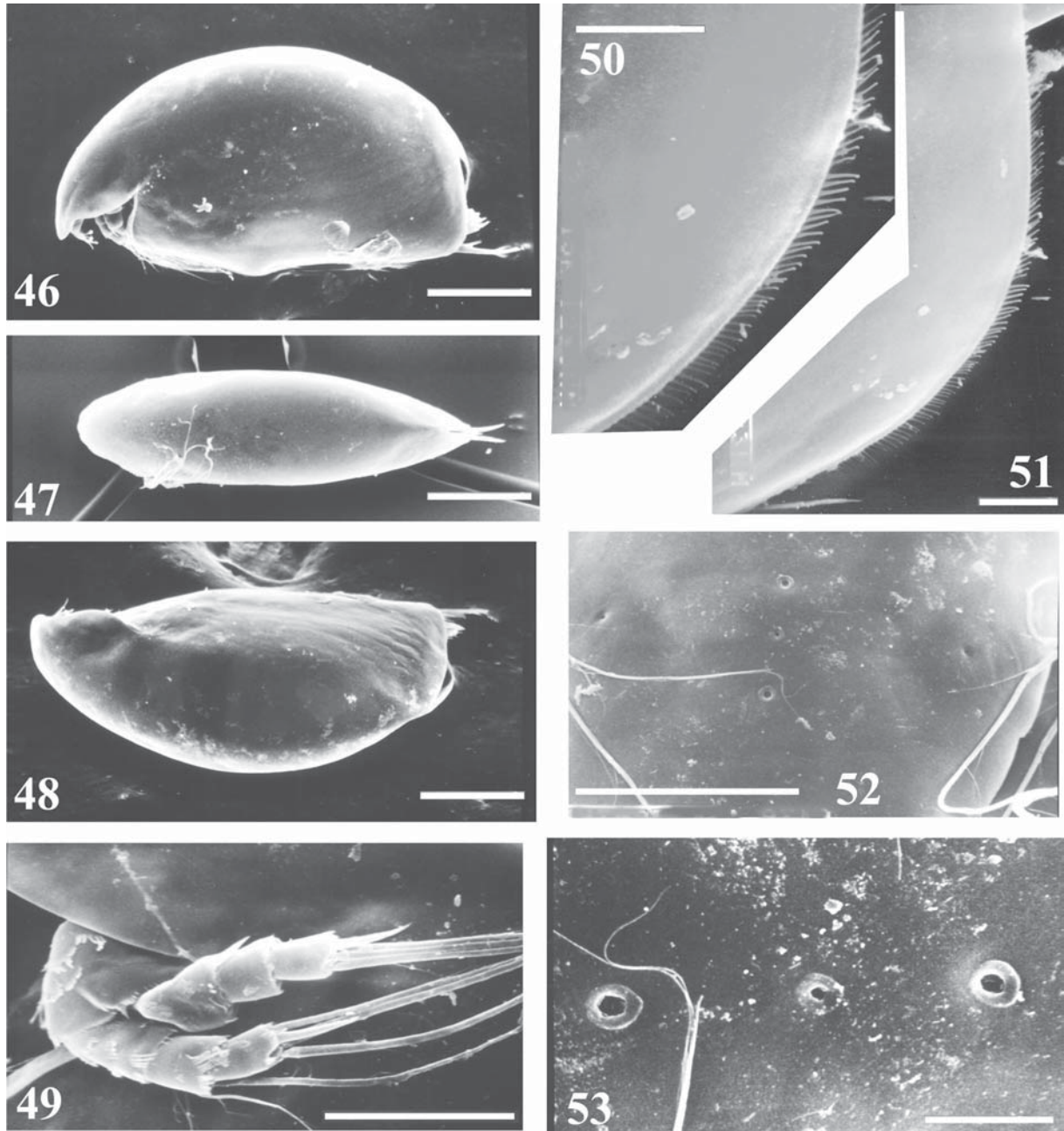
*Thorax* and *abdomen* subequal in length, more elongated than in most other species of *Alona*, dorsal surface of abdominal segments not saddle-shaped. No abdominal projections. No setules present on abdominal segments as seen under optical microscopy.

*Postabdomen* relatively narrow, with parallel margins, length about 2.8-2.9 height (Figs 44-45). Ventral margin from straight



Figs 34-45. *Alona cambouei* Guerne & Richard, 1893 (34, 40, 43-44 — from Sudan, White Nile River; 35-39, 41, 45 — from Iraq, water body in Chybayish; 42 — from Uzbekistan, Tashkent Area, pond of Kalgan-Chirgik fish farm), parthenogenetic female: 34 — lateral view, 35-36 — lateral and dorsal view of the same specimen, 37 — juvenile female of instar II, 38 — juvenile female of instar I, 39 — ventral margin of valves, 40 — head shield; 41-43 — head pores; 44-45 — postabdomen. Scale bars: 0.1 mm (34-38), 0.05 mm (39-45).

Рис. 34-45 *Alona cambouei* Guerne & Richard, 1893 (34, 40, 43-44 — из Судана, река Верхний Нил; 35-39, 41, 45 — из Ирака, водоем в Чубайиш; 42 — из Узбекистана, Ташкентская область, пруд рыбхоза Калган-Чиргик), партеногенетическая самка: 34 — вид сбоку, 35-36 — один и тот же экземпляр, вид сбоку и сверху, 37 — ювенильная самка второго возраста, 38 — ювенильная самка первого возраста, 39 — нижний край створки, 40 — головной щит; 41-43 — головные поры; 44-45 — постабдомен. Масштаб 0,1 мм (34-38), 0,05 мм (39-45).



Figs 46–53. *Alona cambouei* Guerne & Richard, 1893 from Iraq, water body in Chybayish, parthenogenetic female: 46 — lateral view, 47 — dorsal view, 48 — dorso-lateral view, 49 — antennae, 50–51 — posterodorsal angle of valves, 52–53 — head pores. Scale bars: 0.1 mm (46–48), 0.05 mm (49, 52), 0.01 mm (50, 51, 54).

Рис. 46–53. *Alona cambouei* Guerne & Richard, 1893 из Ирака, водоем в Чубайиш, партеногенетическая самка: 46 — вид сбоку, 47 — вид сверху, 48 — вид сбоку-сверху, 49 — антенна, 50–51 — задне-нижний угол створок, 52–53 — головные поры. Масштаб 0,1 мм (46–48), 0,05 мм (49, 52) и 0,01 мм (50, 51, 54).

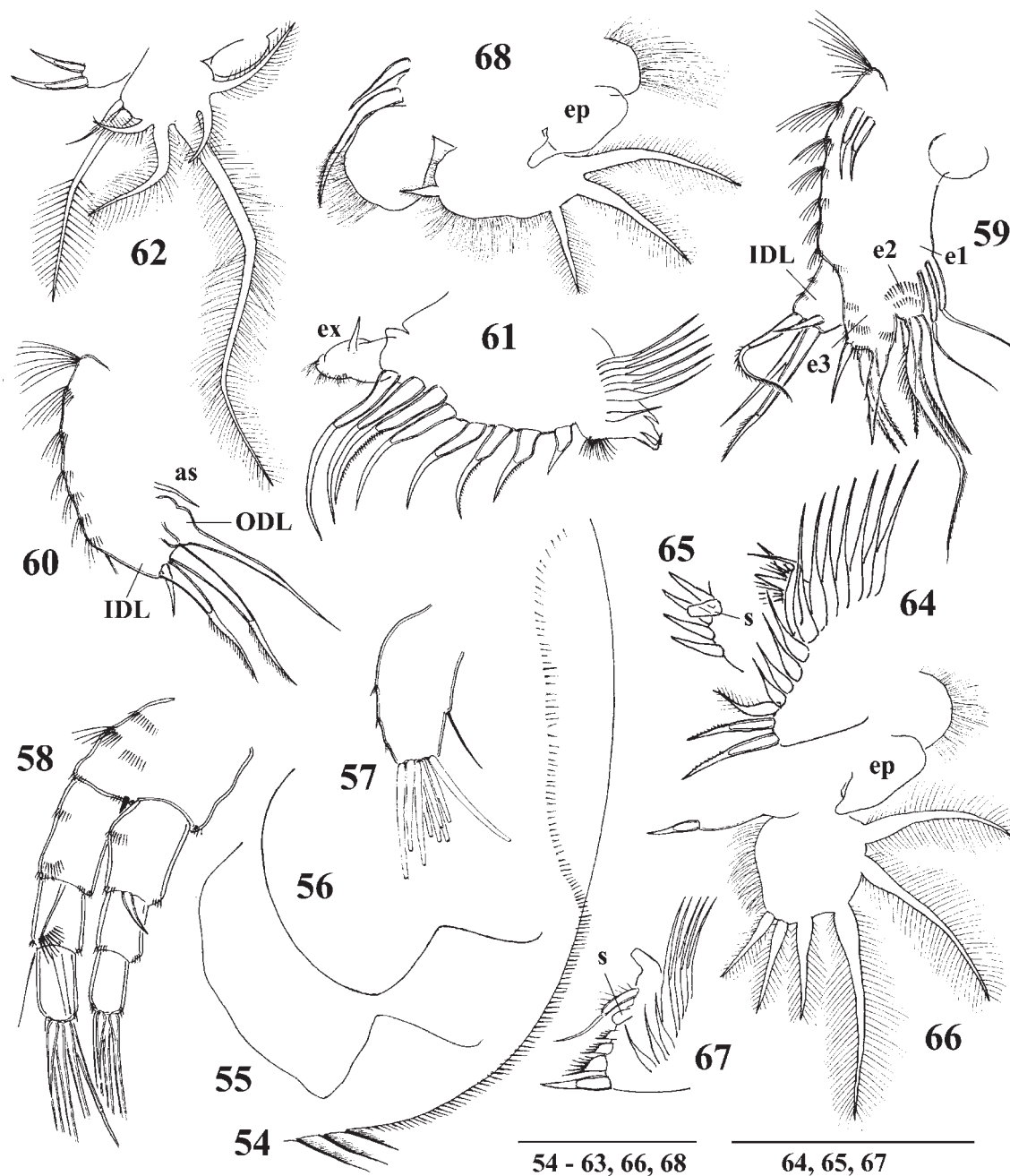
to slightly convex. Inflated basis of claws bordered from distal margin by clear incision. Distal margin straight, rounded angle between distal and dorsal margins. Dorsal margin with distal part about 1.7–2 times longer than preanal one, with postanal portion 1.5 times longer than anal one. Preanal angle prominent, postanal angle weakly defined. Preanal margin straight.

Postabdomen with 7–10 well-developed, sharp, slender marginal denticles, and 3–5 groups of marginal setules on

anal margin. Only 3–5 posteriormost denticles are single, others with additional 1–3 smaller denticles near base. 8–10 lateral fascicles of long setules, posteriormost setae of each fascicle thickest and longest, longer than marginal denticles; no additional row of fascicles seen under optical microscopy.

*Postabdominal claw* of moderate length, subequal to preanal portion of postabdomen. Basal spine slender, sharp, ca. 0.25–0.3 of the claw length.





Figs 47–58. *Alona cambouei* Guerne & Richard, 1893 from Iraq, water body in Chybayish, parthenogenetic female: 54 — posterodorsal angle and posterior margin of valves, 55–56 — labrum, 57 — antennula, 58 — antennae, 59–60 — limb I from inside and outside view, 61 — limb II, 63 — exopodite of limb III, 64 — distal endite and gnathobase of limb III, 65 — basal endite of limb III, 66 — exopodite of limb IV, 67 — inner portion of limb IV, 68 — limb V. Scale bars: 0.05 mm.

Рис. 47–58. *Alona cambouei* Guerne & Richard, 1893 из Ирака, водоем в Чубайиш, партеногенетическая самка: 54 — задне-нижний угол и задний край створок, 55–56 — лябрум, 57 — антеннула, 58 — антенна, 59–60 — нога I, вид изнутри и снаружи, 61 — нога II, 63 — экзоподит ноги III, 64 — дистальный эндит и гнатобаза ноги III, 65 — базальный эндит ноги III, 66 — экзоподит ноги IV, 67 — внутренняя часть ноги IV, 68 — нога V. Масштаб 0,05 мм.

*Antennule* relatively short, robust, not reaching the tip of rostrum, with 2–3 transverse rows of setules at anterior face (Fig. 57). Antennular sensory seta slender, two times shorter than antennule, arising at 2/3 distance from the base. Nine aesthetascs, two of them long and thick, of about 2/3 length of antennule, others relatively short, of similar size. All

aesthetascs projecting beyond anterior margin of the head shield.

*Antenna II* short (Figs 49, 58). Antennal formula, setae 0-0-3/1-1-3, spines 1-0-1/0-0-1. Basal segment robust, branches relatively elongated, all segments cylindrical, with short setules around distal margin. Seta arising from basal segment

of endopod thin, projecting well beyond tip of distal segment. Seta arising from middle segment of endopod of similar size to apical setae. Spine on basal segment of exopod shorter than middle segment. Spine from apical segment of exopod longer than this segment. Apical spine of endopod longer than this segment.

*Trunk limbs:* five pairs.

*Trunk limb I* of moderate size (Figs 59–60). Epipodite oval, without finger-like projection.

Accessory seta short, thin, setulation on it not visible under optical microscope. ODL with one long seta, IDL with three setae and 3 clusters of small setules on ventral face, 1<sup>st</sup> IDL seta short, pointed, 2<sup>nd</sup> and 3<sup>rd</sup> IDL setae 2-segmented, subequal in length, both with setules in distal part.

Endite 3 with four setae, ventralmost seta much shorter and thinner than others. On endite 2 there are three densely feathered setae, middle of them longer than ODL seta. Endite 1 with two 2-segmented setae, both setulated in distal part. No naked setae on anterior face of limb visible under optical microscope. Seven rows of thin long setules on ventral face of limb. Two ejector hooks of similar size. No maxillary process was found.

*Trunk limb II* triangle-round (Fig. 61). Exopodite elongated, with one slender, naked seta, and several clusters of thin setules. Inner portion of limb (“endopodite”) with eight scraping spines increasing progressively in length distally, with equally thin setules on each. A portion of gnathobase bordering with “endopodite” setulated. Distal armature of gnathobase with three elements. Filter plate II with seven setae, the posteriormost member considerably shorter.

*Trunk limb III:* epipodite oval, without finger-like projection. Exopodite of irregular shape, (Fig. 62), supplying with seven setae, subdivided into distal and basal groups. 5<sup>th</sup> (from exopodite) distal setae longest, feathered by long setules, 2<sup>nd</sup> three times shorter, with very long, thick setules in distal part, other distal and lateral setae shorter than 2<sup>nd</sup>, of them 1<sup>st</sup> distal setae naked, other setulated by short setules.

Distal endite with 3 setae, two distalmost members slender, sharp, with distal segments unilaterally armed with short setules; basalmost seta flattened, bilaterally armed with long setules (Fig. 64). Basal endite with 4 stiff, naked setae, increasing in size in basal direction. Gnathobase not clearly separated from basal endite. Four soft setae increasing in size basally (Fig. 65). Distal armature of gnathobase with 4 elements. The first one elongated, cylindrical sensillum, the second geniculated seta, others two spines with fused bases. A bunch of setules near them. Filter plate III with seven setae.

*Trunk limb IV:* Pre-epipodite ovoid, setulated; epipodite elongated, with short finger-like process. Exopodite of irregular shape, with six setae (Fig. 66). Two lateral setae flattened, plumose, subequal in length. Four distal setae of greatly unequal size, distalmost member subequal in length to lateral setae, other much longer. Inner portion of limb IV with four setae (Fig. 67). Distalmost seta naked, stout, 3 others flattened, with reduced distal part, each armed with 5–8 thick setules on distal margin. 3 soft setae increasing in size basally. Gnathobase with long 2-segmented setae and small hillock distally. Filter plate with five setae.

*Trunk limb V:* pre-epipodite setulated. Epipodite elliptical, with short finger-like process (Fig. 67). Exopodite regular oval, not subdivided into two lobes, lateral group with 3 long, densely setulated setae, distally only a single short seta. Inner limb portion as widening distally lobe, with setulated inner margin. At inner face, two densely setulated setae, distalmost very large. No filter plate was found.

*Trunk limb VI* absent.

EPHIPPIAL FEMALE unknown.

MALE: According to the literature [Guerne & Richard, 1893; Dumont et al, 1984; Chen 1993; Venkataraman, 1993], body is more elongated than in female, length about twice maximum height. Postabdomen narrow, with parallel margins. Ventral margin almost straight, with a strong step in region of gonopores, which open ventrally near basis of claws. Dorsal margin almost straight, preanal angle well-defined, postanal angle not defined. Lateral fascicles of setules same as in female, clusters of short setules in place of marginal denticles. Postabdominal claws significantly shorter than those of female, but basal spine of same length as in female.

SIZE: In females of first juvenile instar, length 0.23 to 0.26 mm, height 0.12 to 0.15 mm. In females II, length 0.3 to 0.34 mm, height 0.17 to 0.19 mm. In adult female, length 0.35 to 0.46 mm, height 0.22 to 0.28 mm. According to the literature, length of adult male 0.32 to 0.34 mm.

## Discussion

The main character which separates *A. pulchella* and *A. cambouei* is the presence of a connection between the head pores. As in *A. costata* and *A. setigera* [Sinev, 2000], morphology of head pores here is the most significant difference between closely related species. The following additional differences between these two species are:

1. The maximum size of female is 0.45 mm for *A. cambouei*, and 0.56 mm for *A. pulchella*.
2. The number of notches of posterior margin of head shield is uneven (5 or 7) in *A. cambouei* (Figs 14–15), and the middle notch located in midline. In *A. pulchella* (Figs 41–43), number of notches is even and greater (10 or 12), and central pair of notches located more or less symmetrically from midline.
3. The number of setae on ventral margin of valves is 40–45 in *A. pulchella* (Figs 11–12) and only 30–35 in *A. cambouei* (Fig. 39). In the latter species setae from both anterior and posterior groups of setae are longer, and setae of middle group are shorter than in the former.
4. Preanal angle of the postabdomen is always prominent in *A. cambouei*, and anal margin is strongly concave. In *A. pulchella* the shape of postabdomen is more variable, and preanal angle, especially in larger specimens, may be weakly developed, and anal margin of postabdomen almost straight. The general shapes of the postabdomen are also a bit different, in *A. cambouei* it looks more slender than in *A. pulchella*.
5. In *A. cambouei*, two lateral and closest to them distal setae of exopodite IV are all of similar length, but in *A. pulchella* their length is different.
6. Gnathobase IV of *A. pulchella* have the additional seta, which is not found in *A. cambouei*.

The differences in size of the species are most significant for the analysis of literature data. In most records of the *pulchella*-group animals from Africa and Asia (see above), the length of the parthenogenetic females does not exceed 0.45–0.47 mm, while in Australia, the recorded size of *pulchella*-group specimens was up to 0.55 mm.

This, together with present data and a few works reporting head pores morphology, suggests the follow-

ing pattern of distribution of *A. pulchella* and *A. cambouei* in the Old World. Like a great number of other Chydoridae [Smirnov & Timms, 1983; Smirnov, 1994], *A. pulchella* s.str. seems to be an Australian endemic, and there are no reliable data about its occurrences outside Australia. The distribution of *A. cambouei* is rather wide, and includes South and West Africa and Tropical Asia from Palestine to China. At present we should treat all *pulchella*-group animals from Africa and Asia with unconnected major head pores as a single species. A sample from Queensland, Lake Wombach, containing *pulchella*-like animals with disconnected head pores, suggests two possibilities — either *A. cambouei* also is present in Australia, or there is third, previously undescribed, species of *pulchella*-group in Australia. The exact pattern of distribution of both *A. pulchella* and *A. cambouei* remains unknown.

Relationships of the *pulchella*-group with other species of *Alona* remains obscure. Australian endemic *A. setuloides* Smirnov & Timms, 1986, seems to be most closely related to *pulchella*-group species of *Alona*. This species has a similar narrow postabdomen with parallel margins and well-developed lateral fascicles, similar shape of basal spine on postabdominal claws and IDL setae. Like *A. cambouei*, *A. setuloides* has three unconnected major head pores, and similarly located lateral pores. But it differs from both discussed species by the greater size (length of female 0.68 mm, of male 0.51), and by greater number of both marginal denticles and lateral fascicles on the postabdomen. Other species which may be related to *pulchella*-group are *A. karelica* Stenroos, 1897 and *A. setulosa* Megard, 1967, which both have a similar body shape and postabdomen. Because detailed morphology of appendages of both these species is still unknown, it is impossible to determine the exact degree of their relationship with the *pulchella*-group.

Since males of both species are not fully described, and the ephippial female remains unknown, study of them should be continued. The taxonomic status of *pulchella*-group animals from the New World remains unrevised, and should be rechecked.

#### ACKNOWLEDGEMENTS

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